



The Cambridge Area's water resources

Stephen P. Tomkins

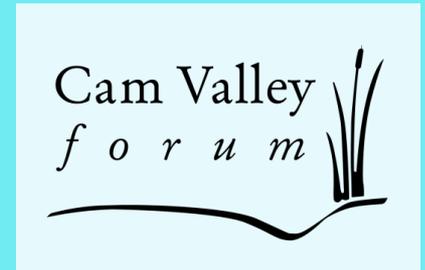
Cam Valley Forum

Why all is not well with the River Cam and its groundwater sources.

What is the Cam Valley Forum ?

A community group concerned with the welfare of the River Cam.

- Its flow & water quality
- Its heritage value and its environmental importance
- Its Natural History
- Its right use for both amenity & recreation.



We want to represent:-

- The people who live and work beside it:
- People whose recreation is beside it: walkers , cyclists, anglers and birders. Etc..
- People who enjoy being in or on it:- boaters, rowers, sailors, canoeists, punters & swimmers.
- **The River itself**.....as it has **no voice, no vote & no advocate**.

We engage with:-

- Local Authorities, City Council, Cam Conservators. Etc..
- Farmers and Landowners.
- Conservation Groups: Wildlife Trust, Cambridge PPF. CPRE, Etc..
- Anglian Water, Affinity Water and Cambridge Water. WRE.
- The Environment Agency, DEFRA and Natural England.

Some River Cam Related Groups

Abington River Care Group
Bin Brook Group
Barrington Conservation Trust
Cam Valley Forum
Friends of the Cherry Hinton Brook
Friends of the River Shep
Friends of the River Granta
Wilbraham River Protection Society
Mel River Restoration Group

Alban Academy Boat Club
Cam Conservators
Cam Rowers
Cam Sailing Club
Cambridge Canoe Club
College College Boat Clubs
Scudamores
Traditional Punting Company

Federation of Cambridge Residents
Associations
Friends of Ditton Meadows
Friends of Queens' Green
Friends of Midsummer Common
Friends of Sheep's Green
Friends of Stourbridge Common
Save Our Open Spaces

Cambridge Past Present and Future
CPRE
The Wildlife Trust
The Countryside Restoration Trust
The Hobson's Conduit Trust

Newnham Riverbank Club

Cambridge Trout Club

Our *Cam Valley Forum's* greatest concerns

Over-abstraction from the Cambridge chalk aquifer hugely reduces flow.

Low flows means that river pollution is made worse.

Augmentation of the river with water pumped from the aquifer helps the
river ,
but it cannot be a long term solution to low flows.
More groundwater is needed now by the rivers

&

In a polluted and degraded river there are real threats to biodiversity and
the life of the river is greatly endangered.

Water shortage, Low river flows, Pollution & Loss of wetlands

The Siren Voices

1965 Cambridge Meeting of the British Association for the Advancement of Science: Cambridge Chalk is a finite source of water,

1970s Hobson's Conduit fails and Nine Wells dries up.

1987 Gro Bruntland "Our Common Future" *World Commission on Environment and Development*. The first call for 'Sustainable Development'

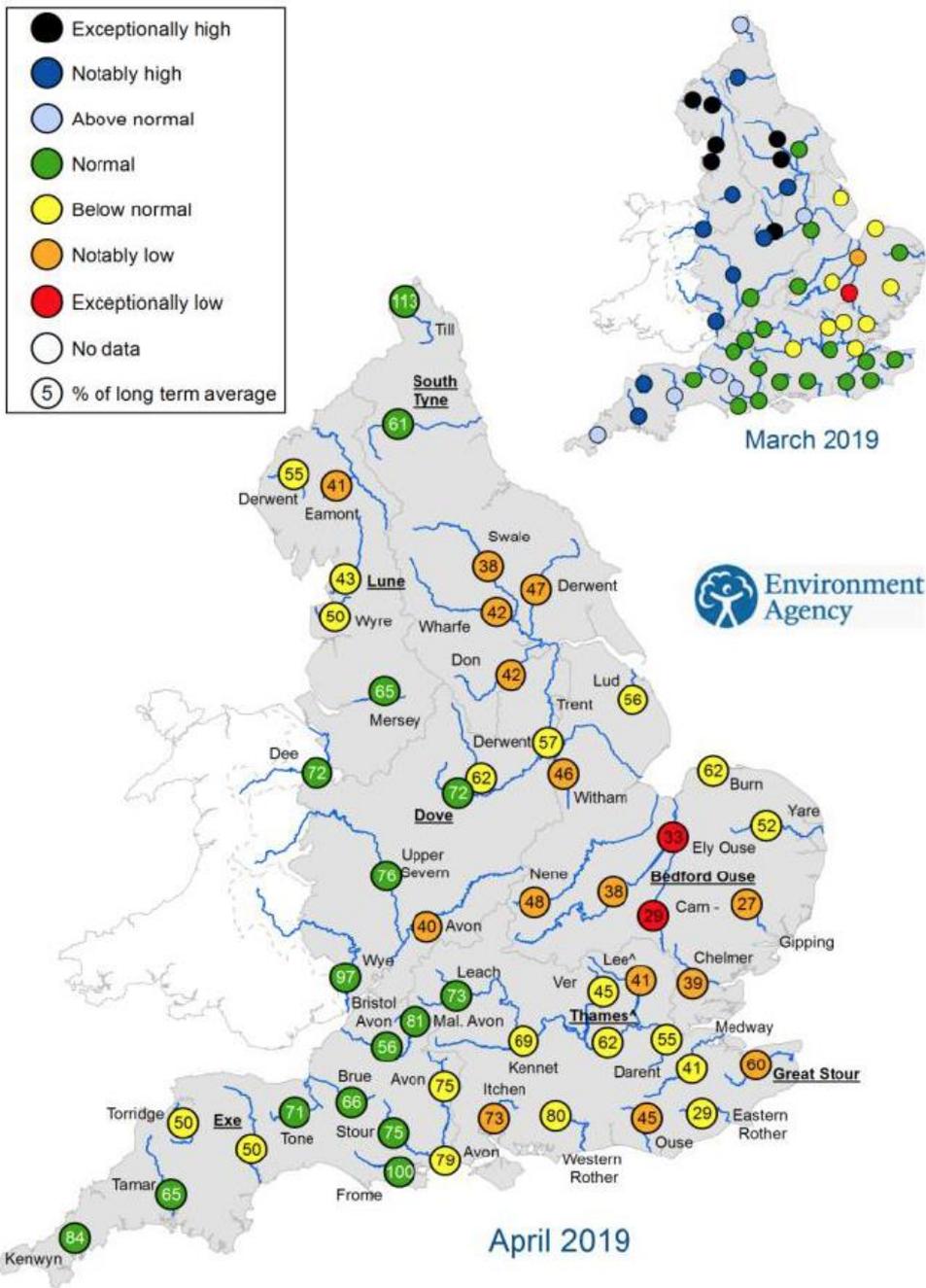
1990s British Geological Survey, The Institute of Hydrology, UK. Failure of the Cam is 'inevitable'.

2000 EC Water Framework Directive.

Our legal obligation to improve watercourses established.

2016 Environment Agency showed that nearly a quarter of all the rivers in England are still at risk from too much water being abstracted, leaving too little for wildlife: parts of the Upper Cam are "poor".

Figure five: River flows (source: the Environment Agency)



Why all is not well with the River Cam.

In Spring 2019 the River Cam had its lowest recorded flow since records first began in 1949

In May, the Wilbraham River Protection Society on their annual spring river walk found their stream dry.

In May, members of the CVF Committee and the Hobson's Conduit Trust also raised the alarm.



Dr Steve Boreham

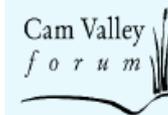


Rob Mungovan



Ruth Hawksley

The River Cam Manifesto



This paper is a plea from *the Cam Valley Forum* addressed to everyone who lives in South Cambridgeshire, in Cambridge City or who knows or loves the River Cam.

We are asking everyone to wake up to the fact that all is not well with our river.

The Cam Valley Forum is a not-for-profit charitable association of local individuals, from diverse environmental and recreational groups that are concerned directly or indirectly with the River Cam and its tributary streams. CVF's mission is to actively defend the River Cam's health and wellbeing - for the sake of its wildlife and environment, for the sake of the many people that enjoy the river and who want to safeguard the River Cam's historic and cultural importance.

For these reasons we address here the various councils and the planning authorities, the Water Companies, the Environment Agency, the farmers and landowners and all business and housing developers. We are very aware that the new combined Cambridgeshire County Council and South Cambridgeshire District Council's next Local Plan is at a very formative stage of development.

The reality is that for too long we have not honoured our river sufficiently with protection or understood its real nature. The pressures of our current life style, which is resource dependent, lacks an appreciation of natural systems and carries the strong probability that future infrastructure development will continue on the same lines. This should make us all fear for the future. Many factors are key to the problem (we list ten in depth) and they need to be better understood by every informed citizen.

Summary

1. The River Cam does not have enough water flow to function properly. We have caused this to be the case. It is not just 'the weather'
2. Cambridgeshire is a naturally low rainfall area, but this is not the only reason for poor river flows. Our rainfall is very variable.
3. Over abstraction of water from the ground is the main reason. We pump too much water out of the chalk for our domestic supplies and, to a smaller extent, for agriculture. Water abstraction should not be viewed as a 'right' but only as a privilege.
4. The Chalk hills near Cambridge are where the water comes from. Chalk streams are very special (we have 85% of the worlds total) and we will lose them in England if we are not careful.
5. The Environment Agency already pumps extra water from the Chalk to support stream flows. This help is not enough and is only done because we have taken too much.
6. Most would agree that we should aim for sustainable development where we do not cause harm to our environment or compromise the needs of future generations.
7. Low river flows are added to by insufficiently treated water from sewage works. This is why the upper Cam is largely classed as of 'poor' water quality. Our wild plants and animals have an entitlement to the quality water our environment can provide.
8. A river, such as ours, can be better managed to be more resilient. This will help ease the problems of climate change, and both the occasional flooding and drought.
9. Saving water will help the river Cam. Here there is much we can all do.
10. Helping the river requires us to reassess our values. Our rivers could be cleaner healthier and something to be really proud of. We need to take action now.



August and Sept 2019.
The River Granta at Stapleford : had zero flow.

The Cam Valley Catchment

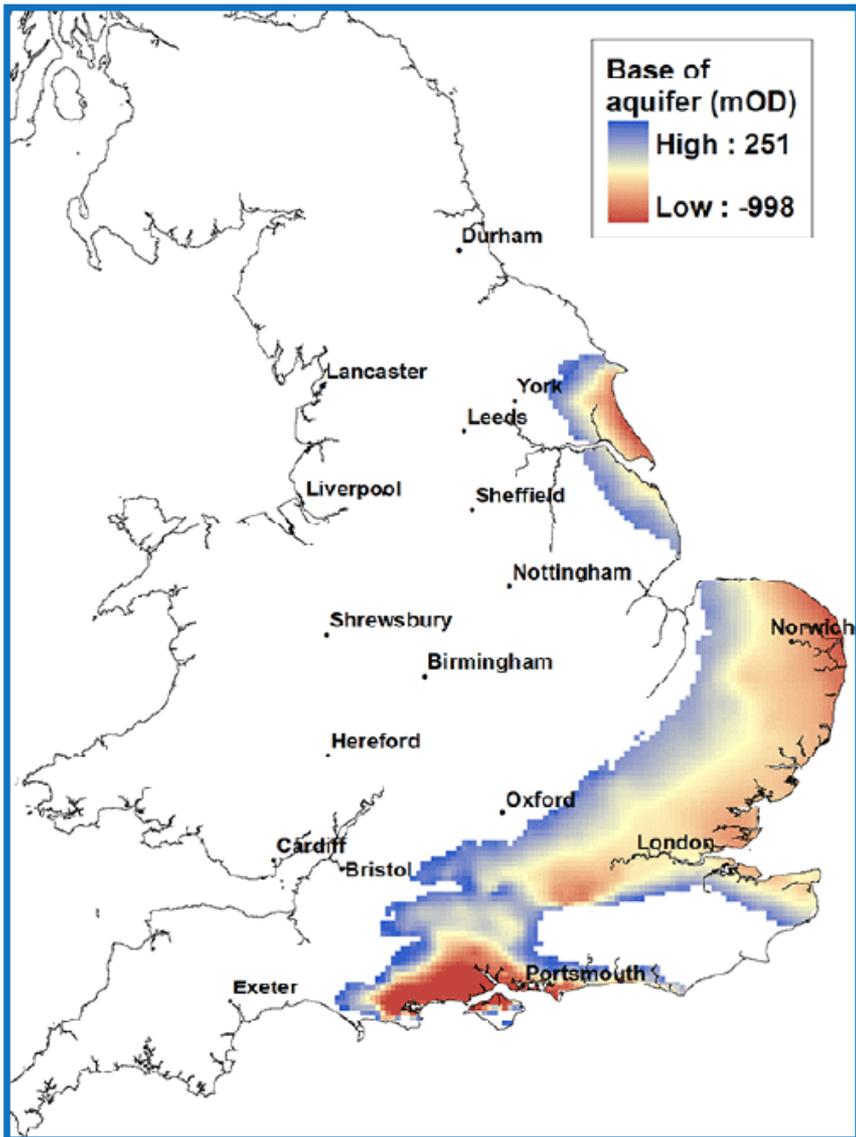
Our Three Main Rivers

**The Cam
The Granta
The Rhee**

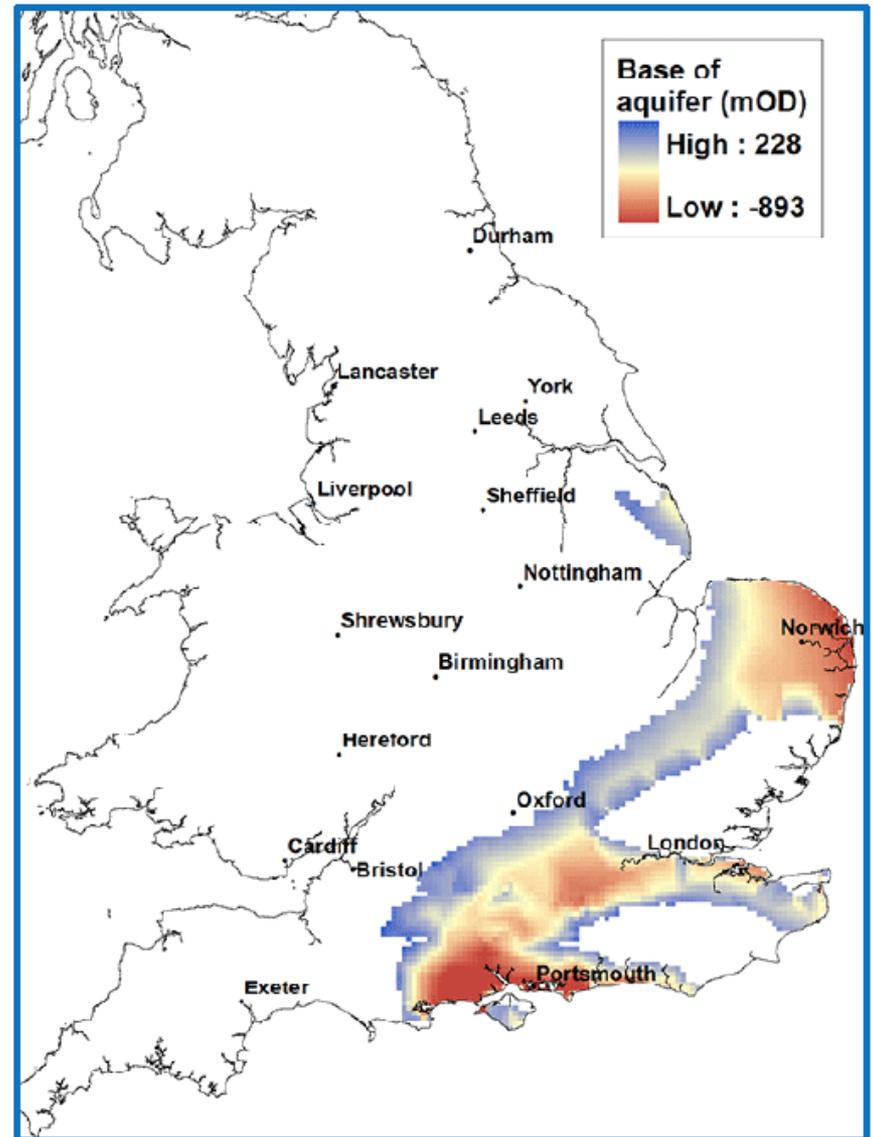
The other Cam tributaries

The Bourn Brook
The Bin Brook
Hobson's Brook
The Lodes
The Wilbraham R.
The Shep
The Mel
The Hoffer Brook





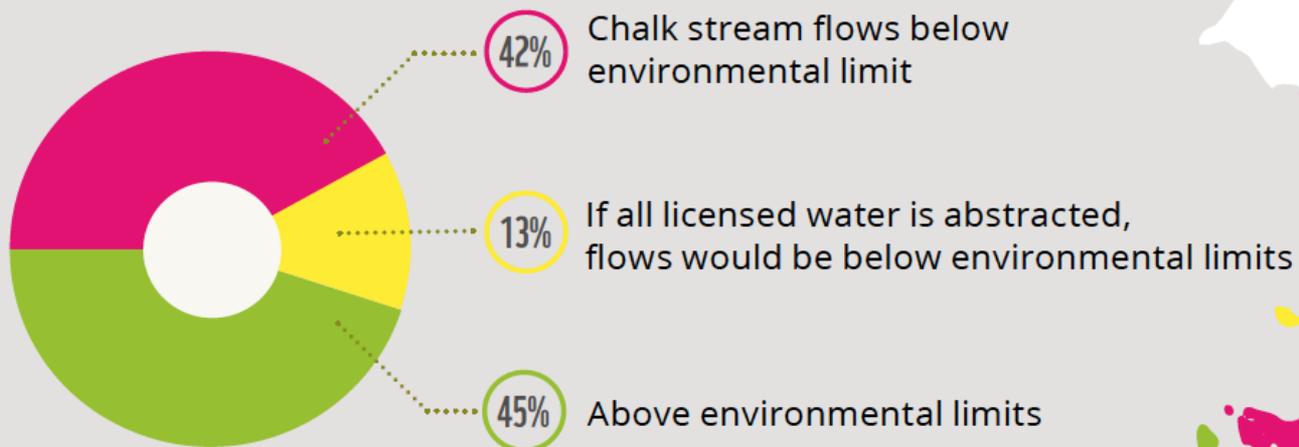
Chalk Aquifers



Lower Greensand Aquifers

Chalk stream flow in relation to Environmental Flow Index compliance

Chalk stream flows in reference to the environmental limits during the driest periods (from the Environment Agency's Catchment Abstraction Management Strategies (CAMS)).



The Uniqueness of Chalk Streams

80 % of Europe's Chalks Streams
are in the UK.

Winter rain falls on the Chalk soils.



At full field capacity, water in the
soil percolates into the aquifer.



Aquifer groundwater
reservoir storage of base-rich
water in the Chalk



→ Spring water



Emergence above a basal
impermeable stratum



The Flora and Fauna of Chalk Streams



Rainfall

The majority of summer rainfall is lost in evapotranspiration.

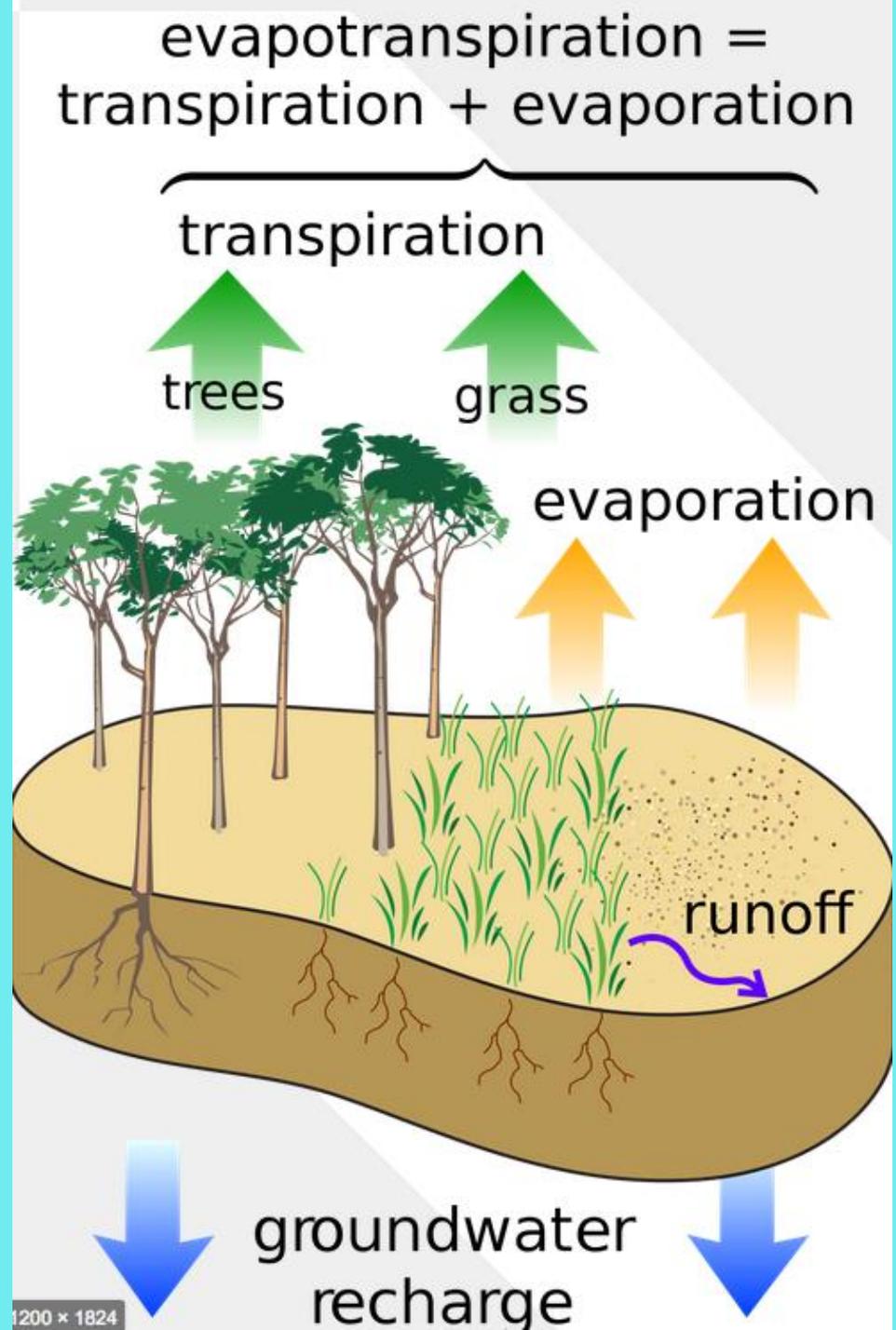
Commonly only the winter rainfall, which percolates deep into the soil, contributes anything to our chalk streams

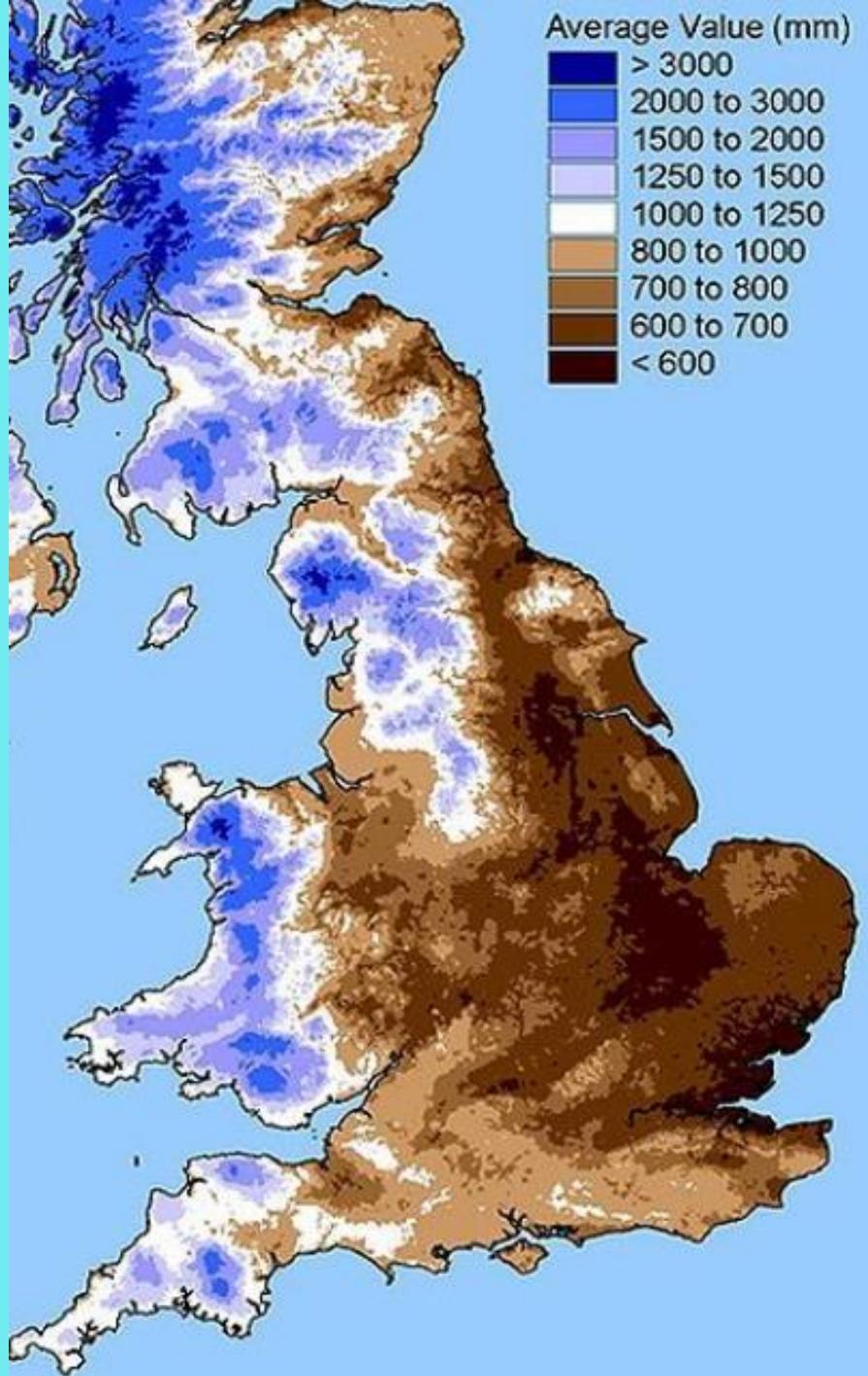
The Granta, Cam and Rhee flows are therefore **winter rainfall dependent**.

Are we short of winter rainfall?

Are we increasingly short all round?

Is this 'climate change' in our rainfall patterns?





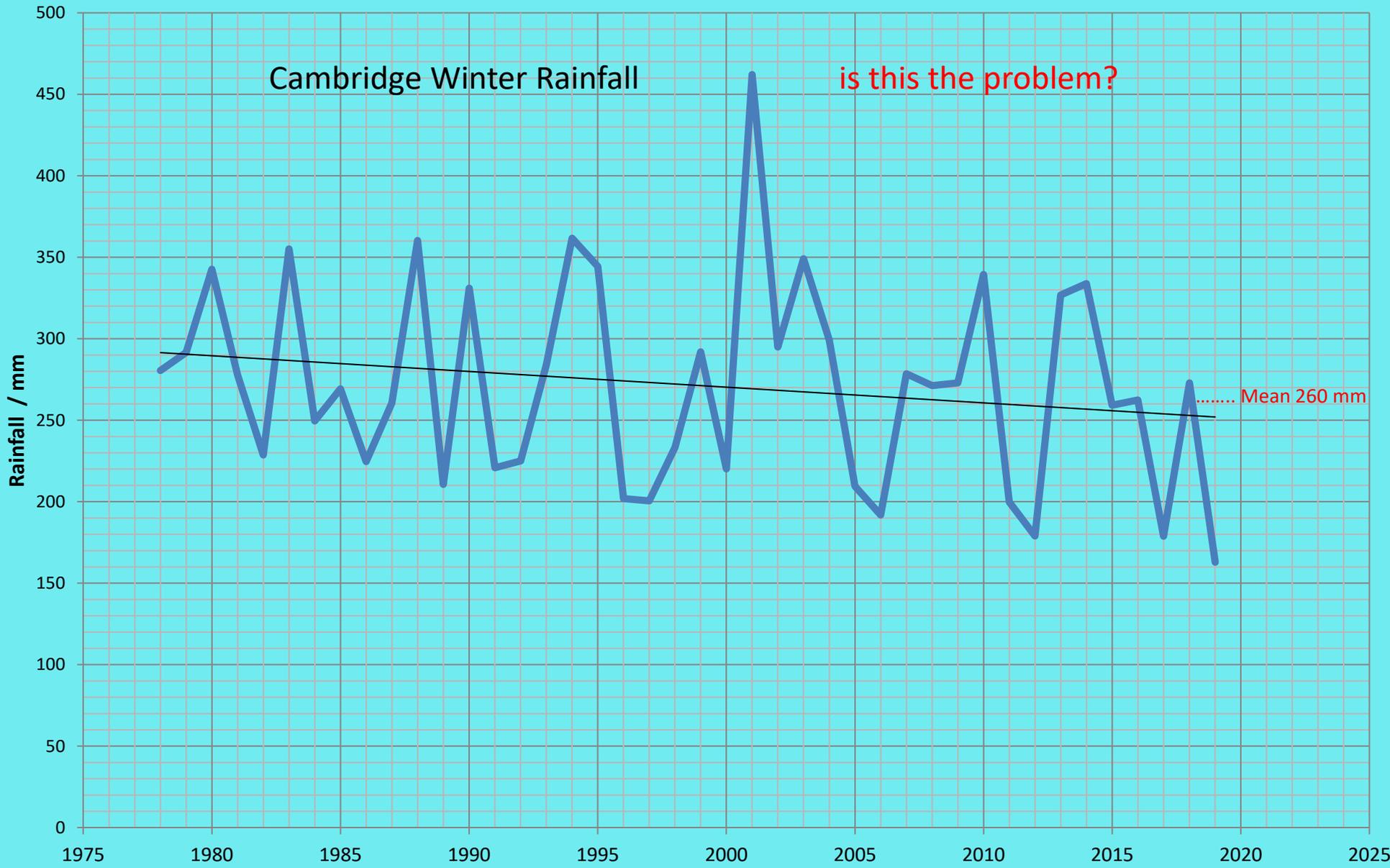
Rainfall

Cambridge is one of the driest places in Britain.

Stretham (on the road to Ely) is one of the driest places locally.

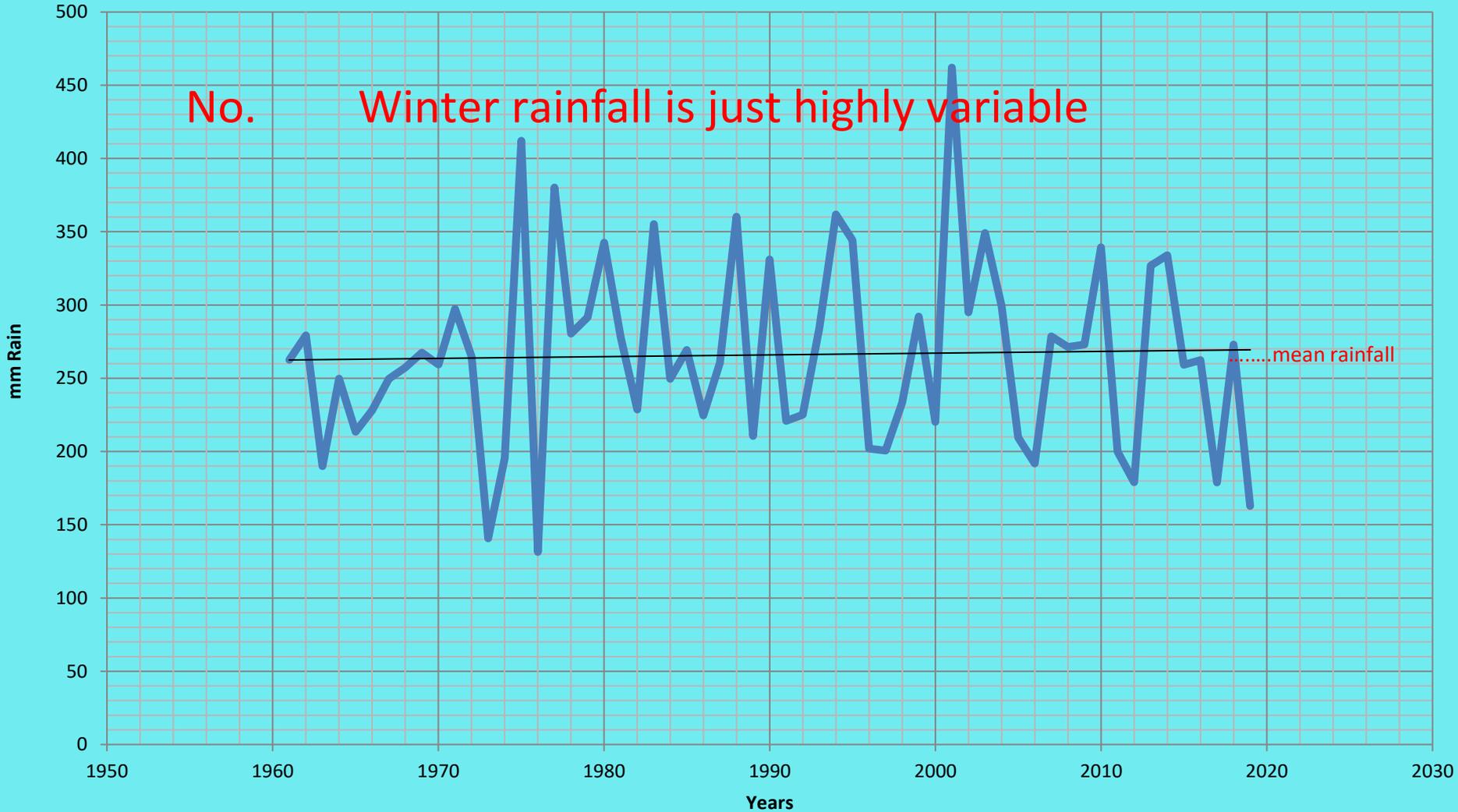
Our mean Cambridge rainfall is only 560 mm

Relative to our water demand we are in a 'water stressed region' comparable to Spain or Morocco.



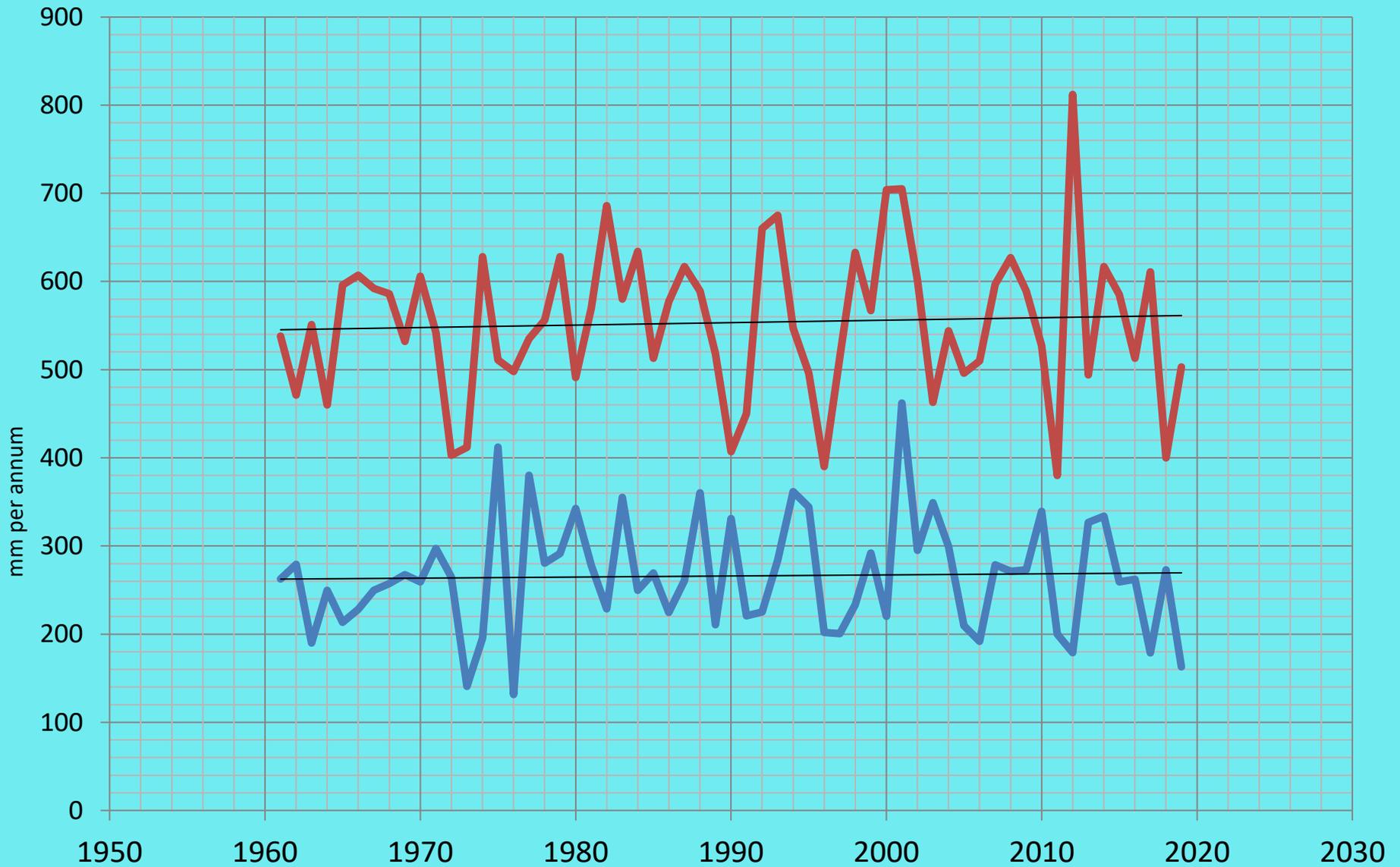
Cambridge City: Winter Rainfall (Oct to March) for the winters ending, as dated

Winter rainfall is the source of most ground water: (for winters Oct to March, ending in year shown)



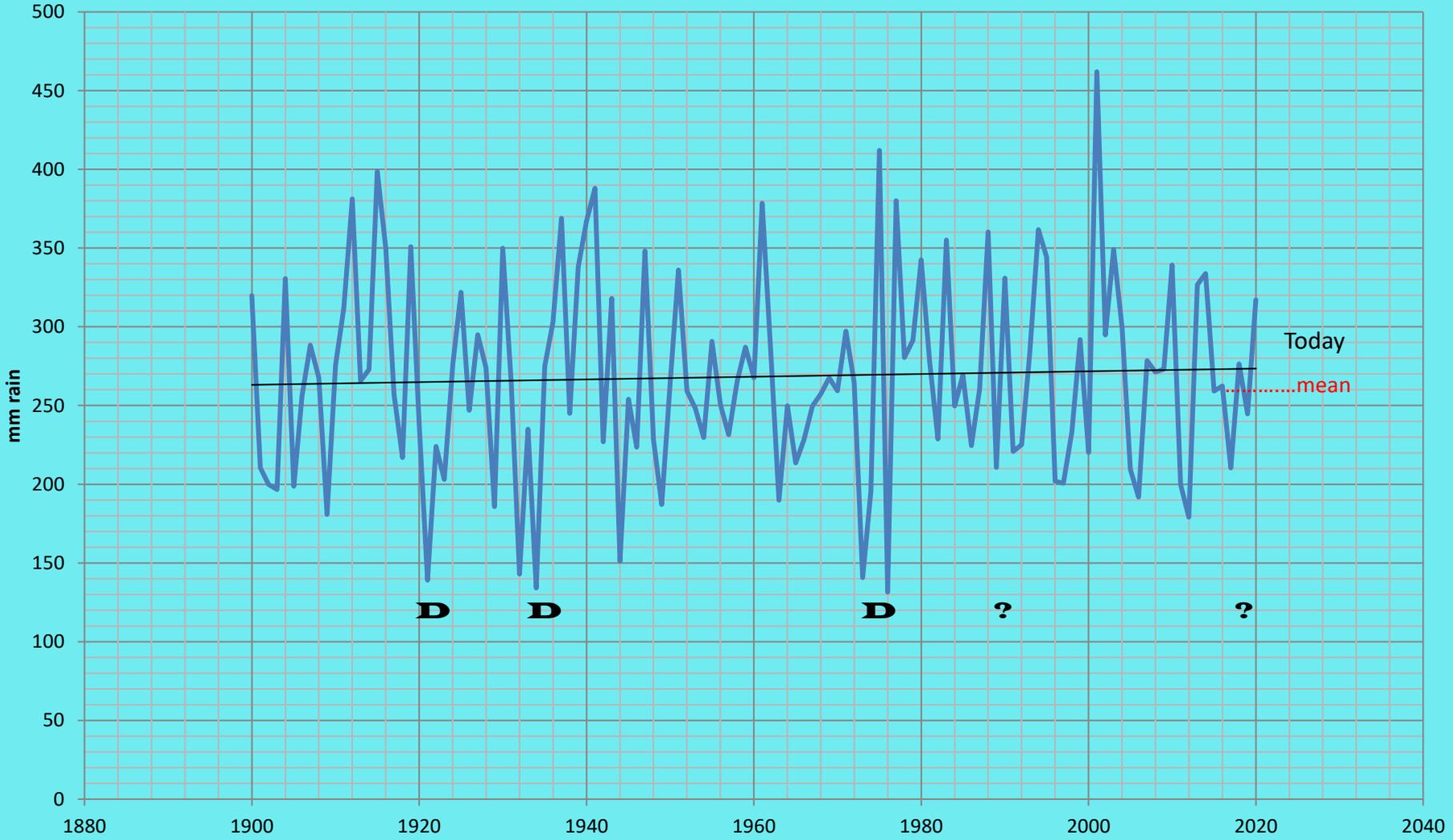
The 60 year mean is essentially unchanged but the variance is great: (SD is +/- 16 % of mean rainfall)
Over 40 years there is possibly a downward trend in winter rainfall (is this climate change ?)

Cambridge's Annual Rainfall (red) and Winter rainfall (blue)

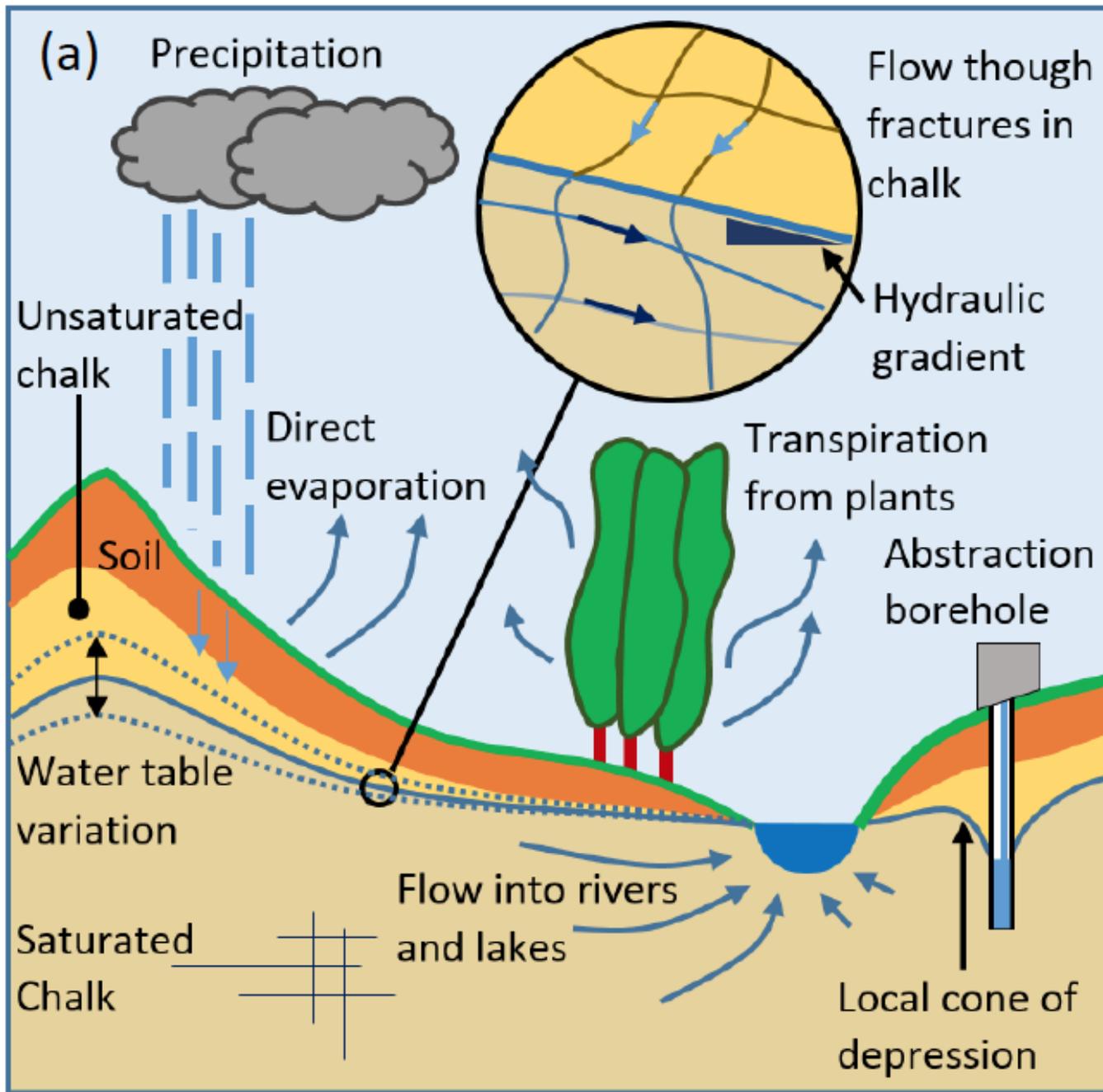


58 years of data from the University Botanic Garden 1962 to 2019

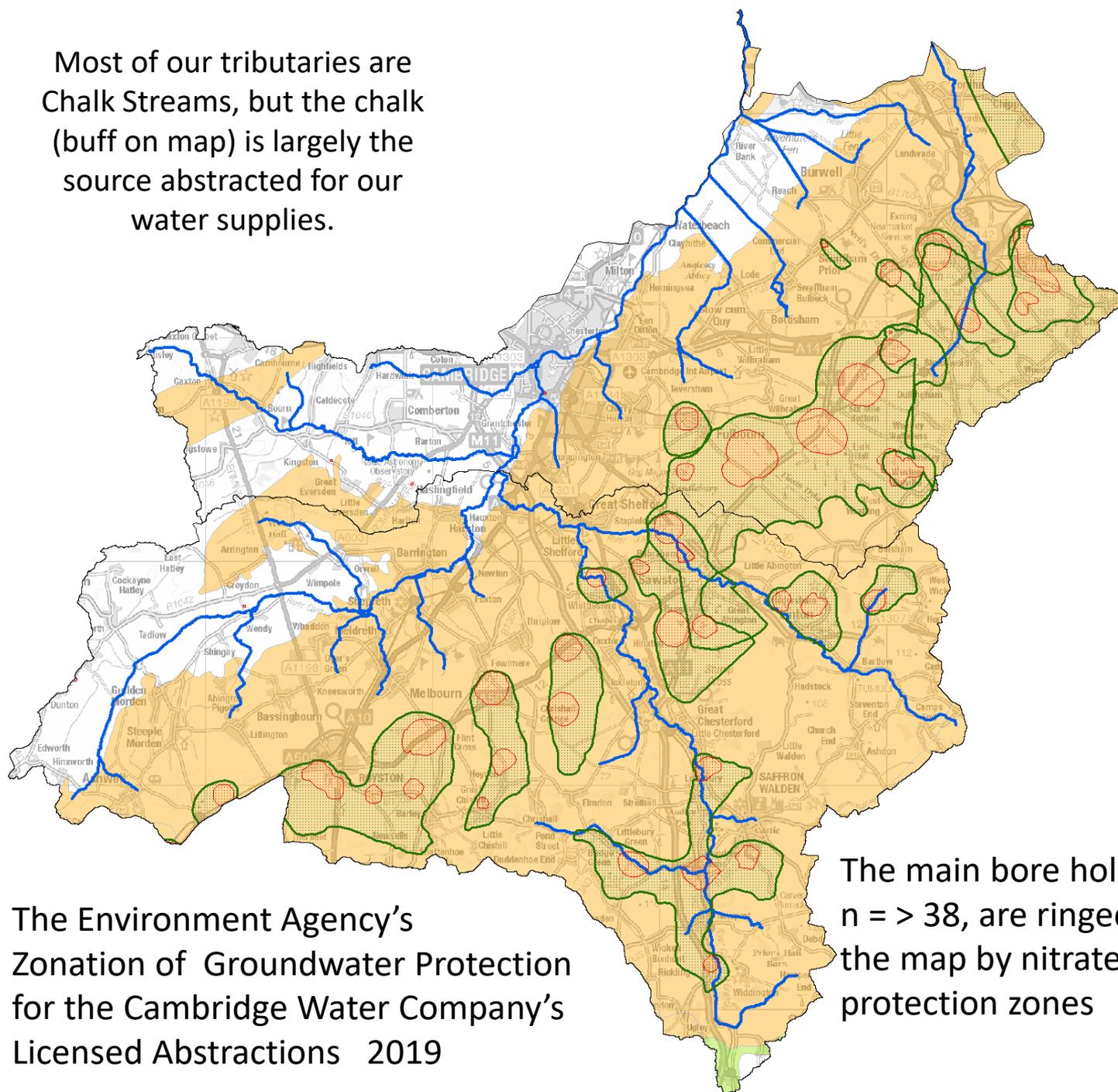
Rainfall deficit is really not the cause of Cambridge Chalk's ground water shortage



D = Bad Environmental Drought years



Most of our tributaries are Chalk Streams, but the chalk (buff on map) is largely the source abstracted for our water supplies.



The Environment Agency's Zonation of Groundwater Protection for the Cambridge Water Company's Licensed Abstractions 2019

The main bore holes, $n = > 38$, are ringed on the map by nitrate protection zones

Cambridge's drinking water sources

Hobson's conduit was built from **Nine Wells** in **1610**.

This was the main source of Cambridge drinking water for over 250 years.

Cherry Hinton Pumping Station: 1855 (the Cambridge Water Company)
main source of Cambridge drinking water for 45 years

Fulbourn Village Pumping Station :. 1891

Sourced all Cambridge water for 30 years.

One of the earliest chlorinated supplies in the UK.

The Fleam Dyke Pumping Station
(right): built **1921**.

The first of the now many
Cambridge Water Company's deep
chalk wells.

As the first deep pump borehole it
supplied half the (old) County of
Cambs and Isle of Ely with water
until 1950.



Droughts and Augmentation.

1890 The Fulbourn 'Poors Fen' begins to dry up and Fulbourn Fen loses water: Fen drainage or chalk abstraction?

In the mid 1970s drought the Cambridge Water Company (unusually) had no restrictions, but Nine Wells dried up for the first time in recorded history and possibly for the first time since the last Ice Age. Wetland SSSIs now threatened.

1991 saw a 'three year drought'.
The Ground Water Support scheme was initiated.

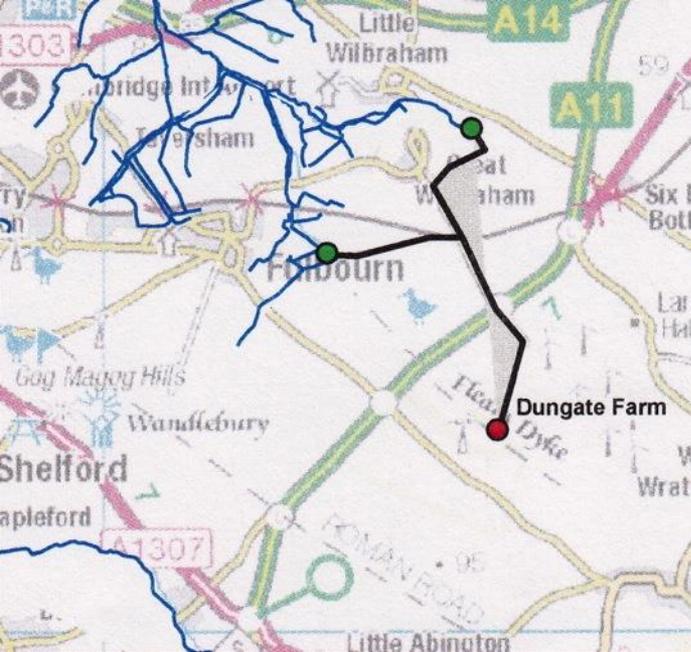
"This river support scheme is now under construction. It has been possible to manage the water resources of the area in ways to benefit all concerned. The provision of increased water for public supply will not be at the expense of low flows in rivers, streams and wetland conservation areas."

Hydrological Basis of Ecologically Sound Management of Soil and Groundwater
(Proceedings of the Vienna Symposium, August 1991). IAHS Publ. no. 202, 1991.

Groundwater support of stream flows in the Cambridge area, UK

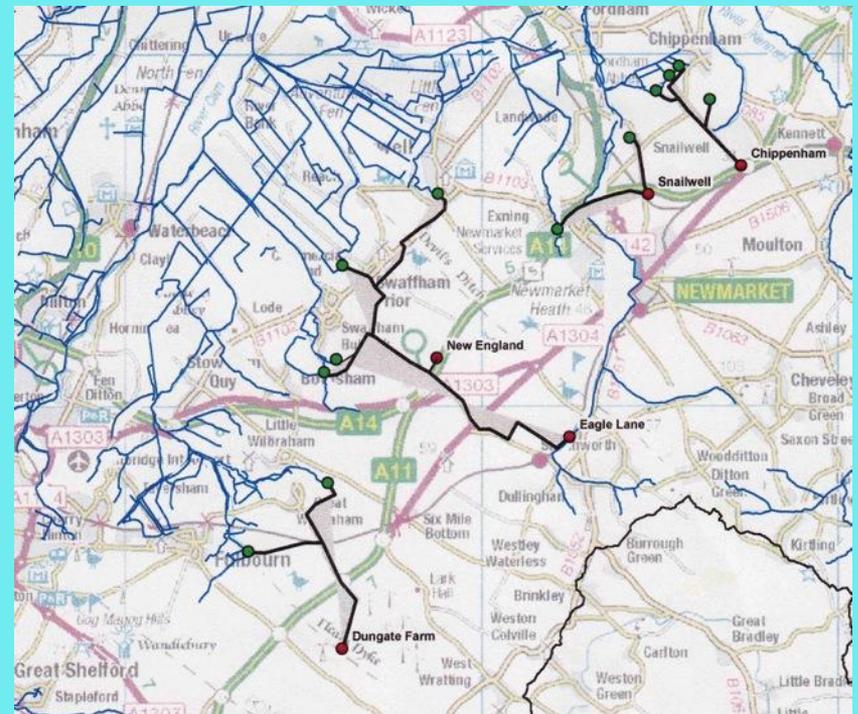
K. R. RUSHTON
School of Civil Engineering, University of Birmingham,
Edgbaston, Birmingham B15 2TT, UK
N. P. FAWTHROP
National Rivers Authority, Anglian Region, Peterborough
PE2 0ZR, UK

ABSTRACT This paper describes a feasibility study for the maintenance of stream flows during dry summer months in an area of Cambridgeshire. Groundwater pumped from boreholes is used for augmentation. A mathematical model was used to represent the study area and led to an improved understanding of the aquifer flow mechanisms. Groundwater flow within horizons of high hydraulic conductivity is controlled by rapidly fluctuating head gradients. The model was subsequently used to aid the design of a river support scheme.

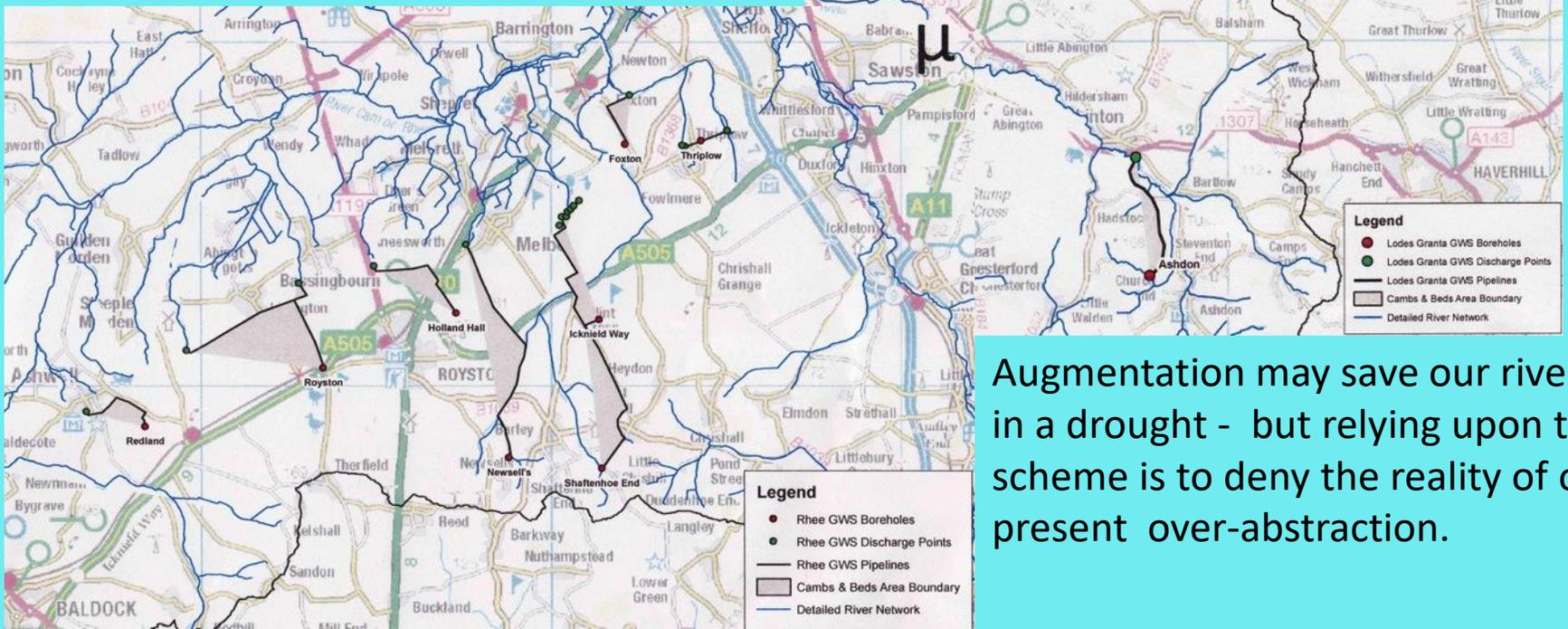


14 pumped borehole sources

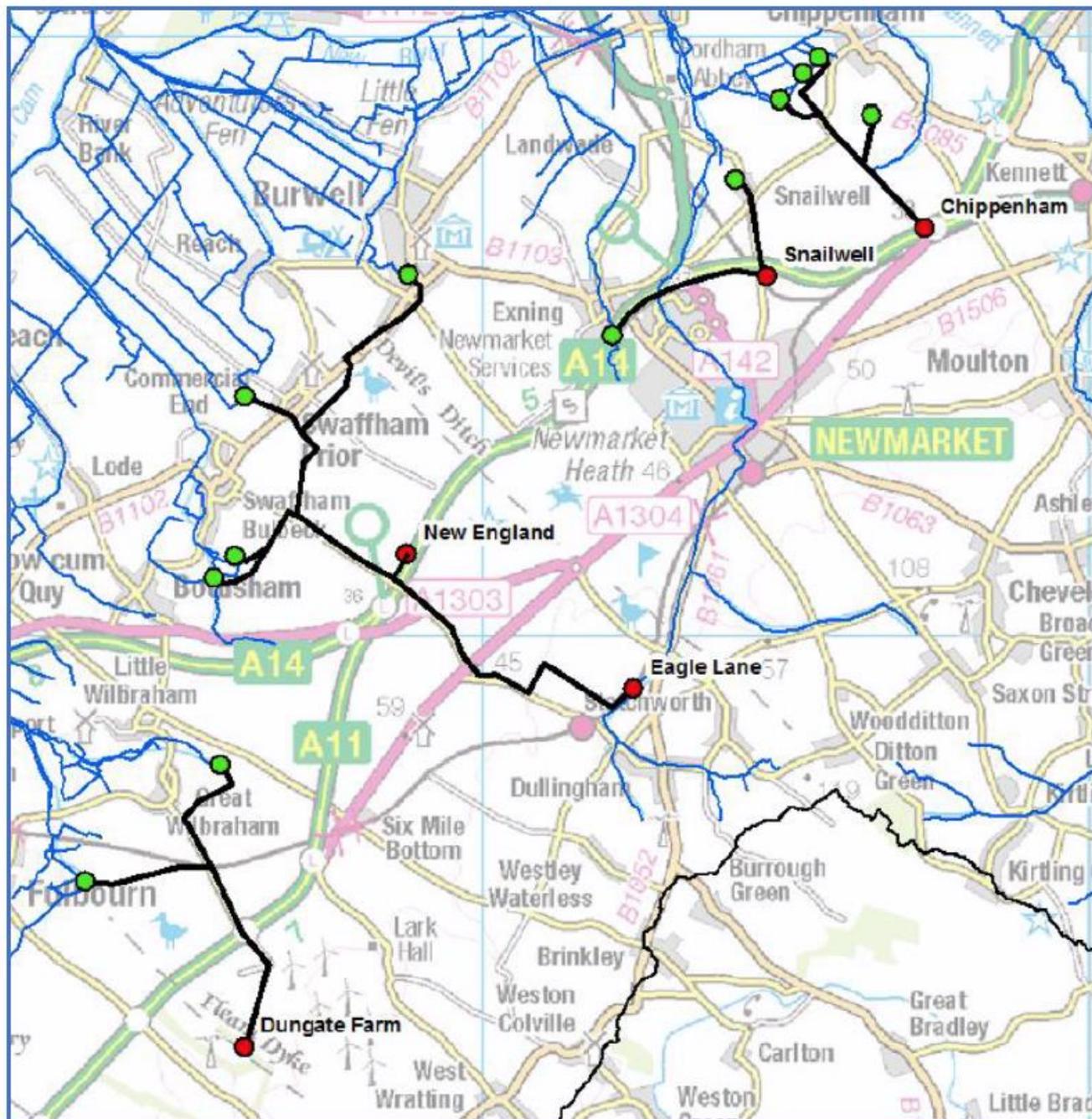
28 'spring' outfalls to chalk streams



The Groundwater Support Scheme

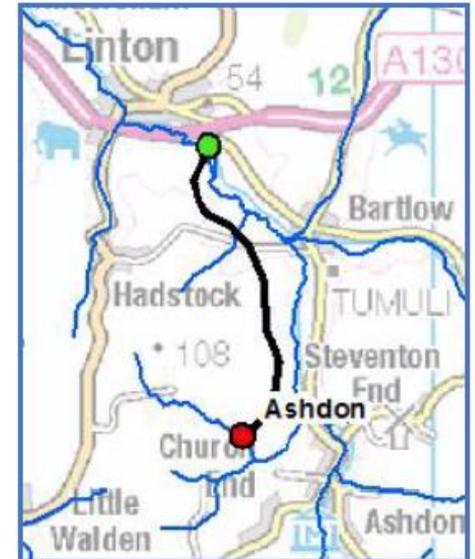


Augmentation may save our rivers in a drought - but relying upon this scheme is to deny the reality of our present over-abstraction.



Legend

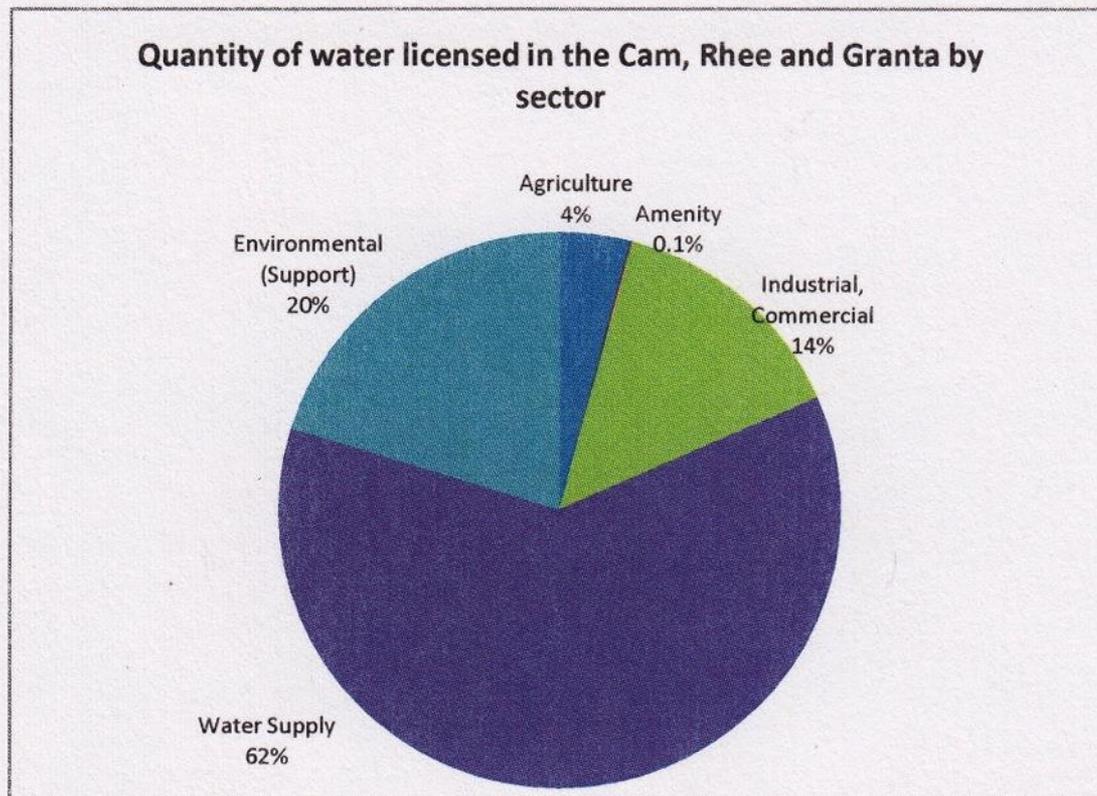
- Lodes Granta GWS Boreholes
- Lodes Granta GWS Discharge Points
- Lodes Granta GWS Pipelines
- Cambs & Beds Area Boundary
- Detailed River Network



Boreholes are shown in red (to the south) and 'spring heads' in green (generally to the north).

Total quantity of water licensed in the Cam, Rhee and Granta by sector

Row Labels	%
Agriculture	4%
Amenity	0.1%
Industrial, Commercial	14%
Water Supply	61%
Environmental (Support)	20%
Grand Total	100%



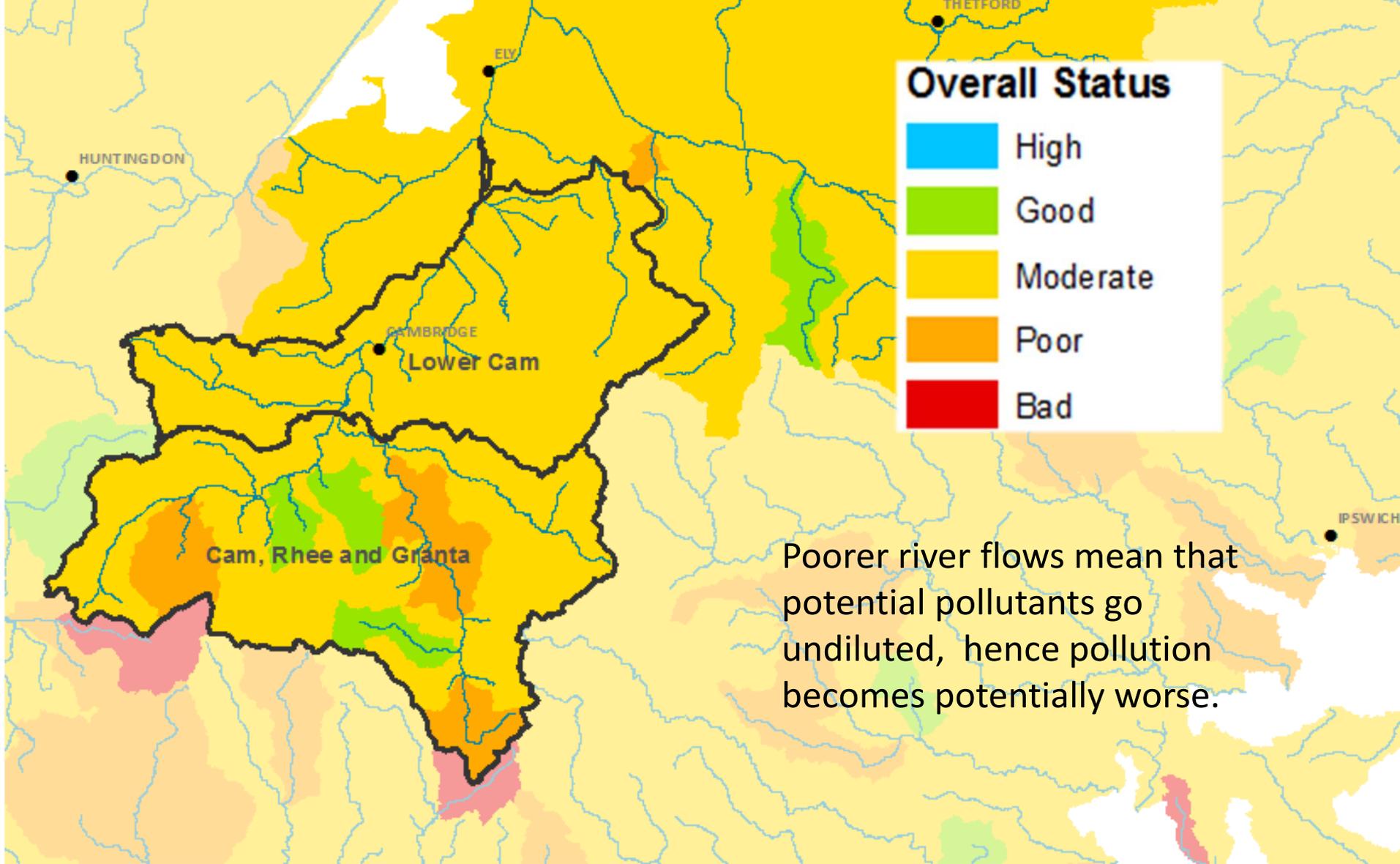
EA data 2015

‘Augmentation’ is 20% of total abstraction.

Your water bill calls it ‘environmental support’

In March 2015 the EA ceased all ‘environmental support’ for three months due to “the expiry of EA owned abstraction licences”
The WFD was cited as a cause of the delay in the re-licensing.

Lode Mill could not run for want of water in 2015.



The Water Pollution Status of the River Cam

(last full survey by Environment Agency was 2016)

Pollution

- The EA data on this is quite superb but is little known by the public. The Environment Agency has been cut back relentlessly.
- With reduced river flows insufficiently treated sewage and septic tank leakage is not diluted. The Cam, from Saffron Walden, south of Byron's pool has **poor water quality** largely for this reason.
- There are still small sewage works not removing phosphate sufficiently.
- Milton Sewage Works (Anglian Water) is now greatly improved and can fully process 1276 dm³ sewage per second. But it is not perfect. It still pollutes and breaches the set limits and Anglian is rarely fined.
- Cam river flows at Baits Bite may be >40% treated sewage at low flow times. In early May 2020 the Cam flowed *backwards* from Milton towards the City.
- **Biodiversity:** Cambridge has already lost 23 species of water plants out of 66 species once recorded here. This is largely attributed to historic water pollution. It is possibly slightly improving on historic lows.

How much does river flow vary ?

We have access to good flow data for the three main contributory Chalk streams of the Cam Valley: the Cam, the Granta and the Rhee.

An EA flow measuring weir ;

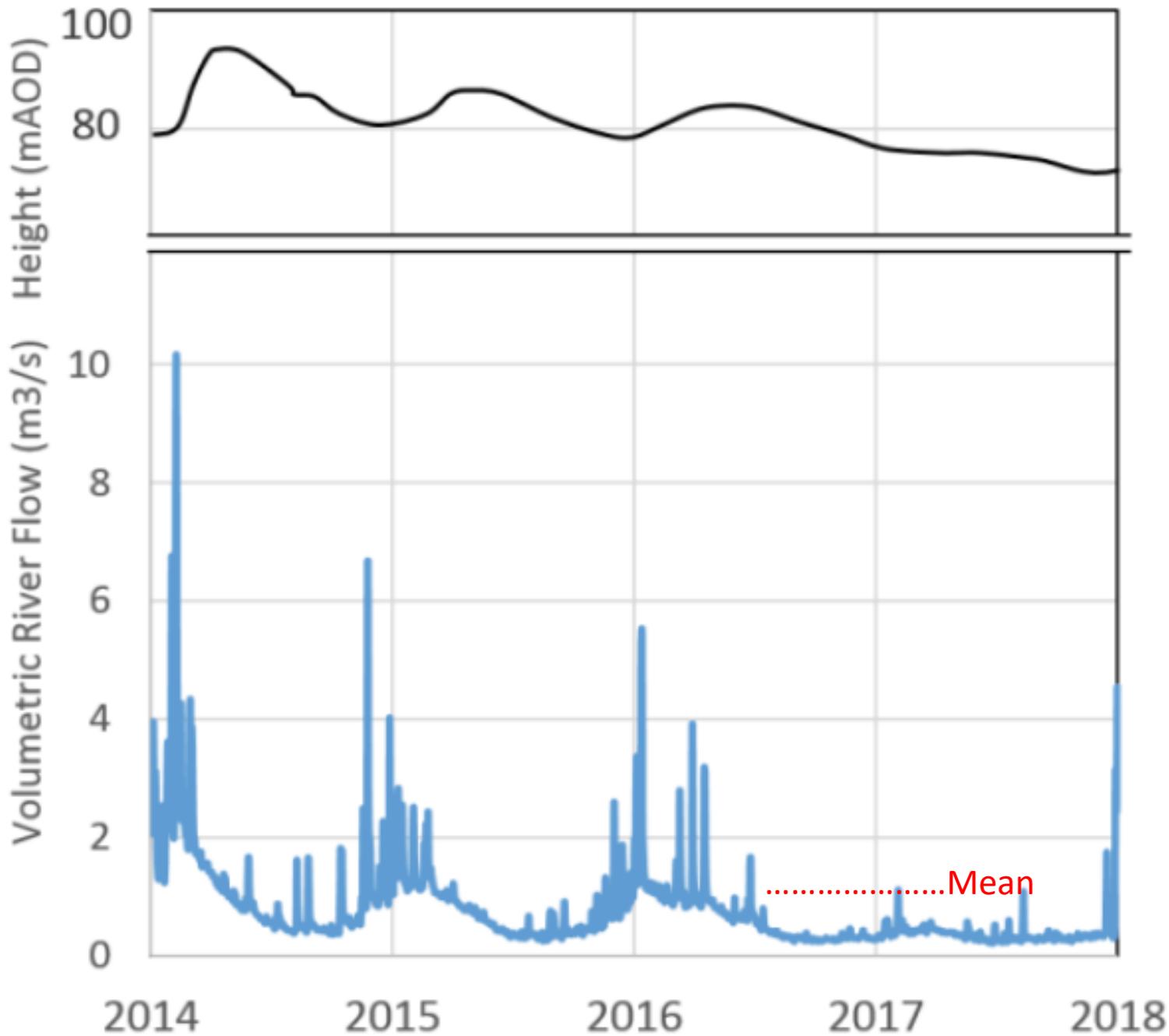
often these are now remotely monitored and data is live and commonly on-line.



Flow Rates of the River Cam at Dernford: 1980-2018, over the last 38 years (EA data) .



Flow is very variable, year on year, and seems to be reducing.



Groundwater
Depth
(metres)

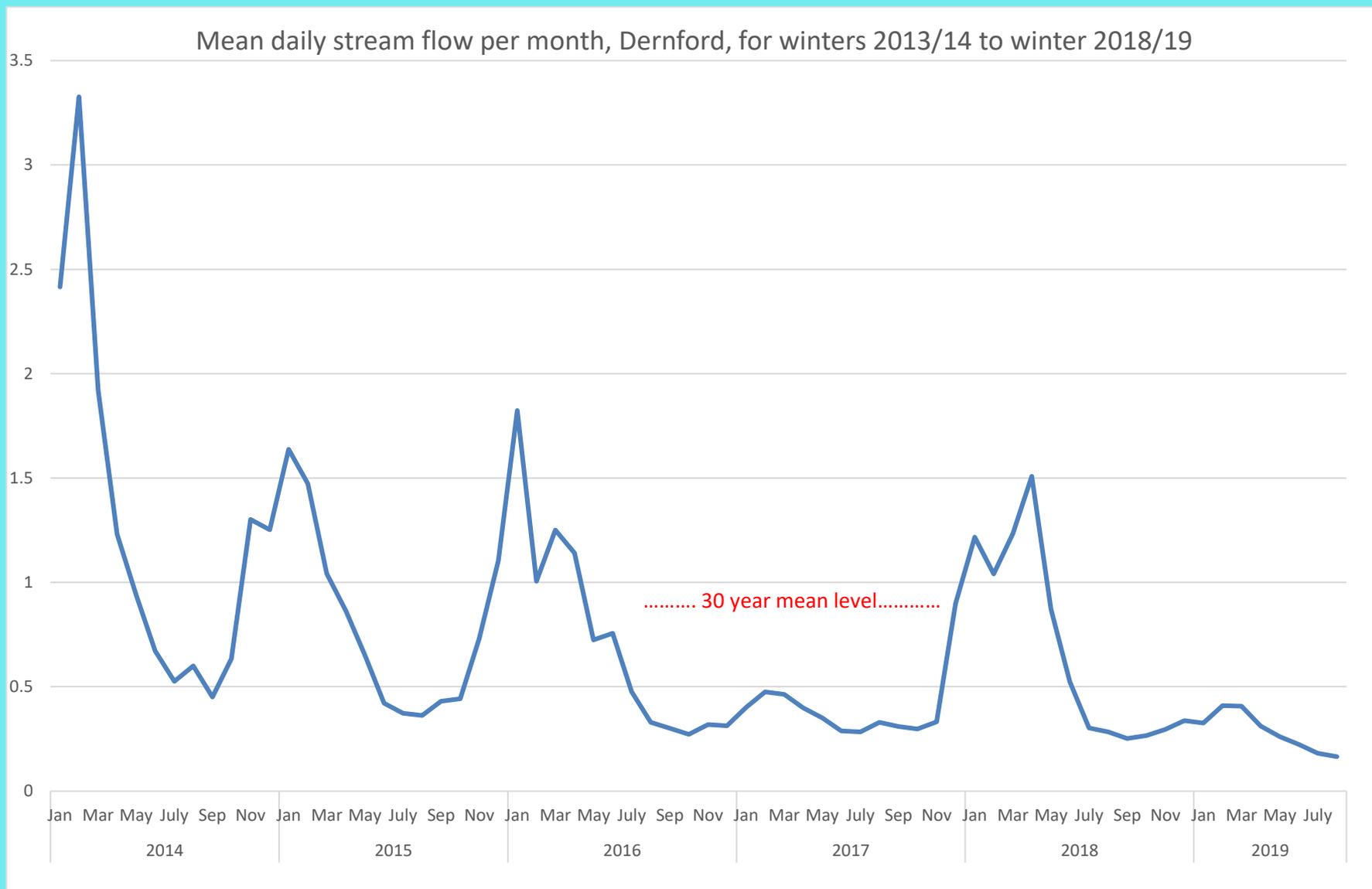
Therfield Heath

River Flow
of the Cam

at Dernford

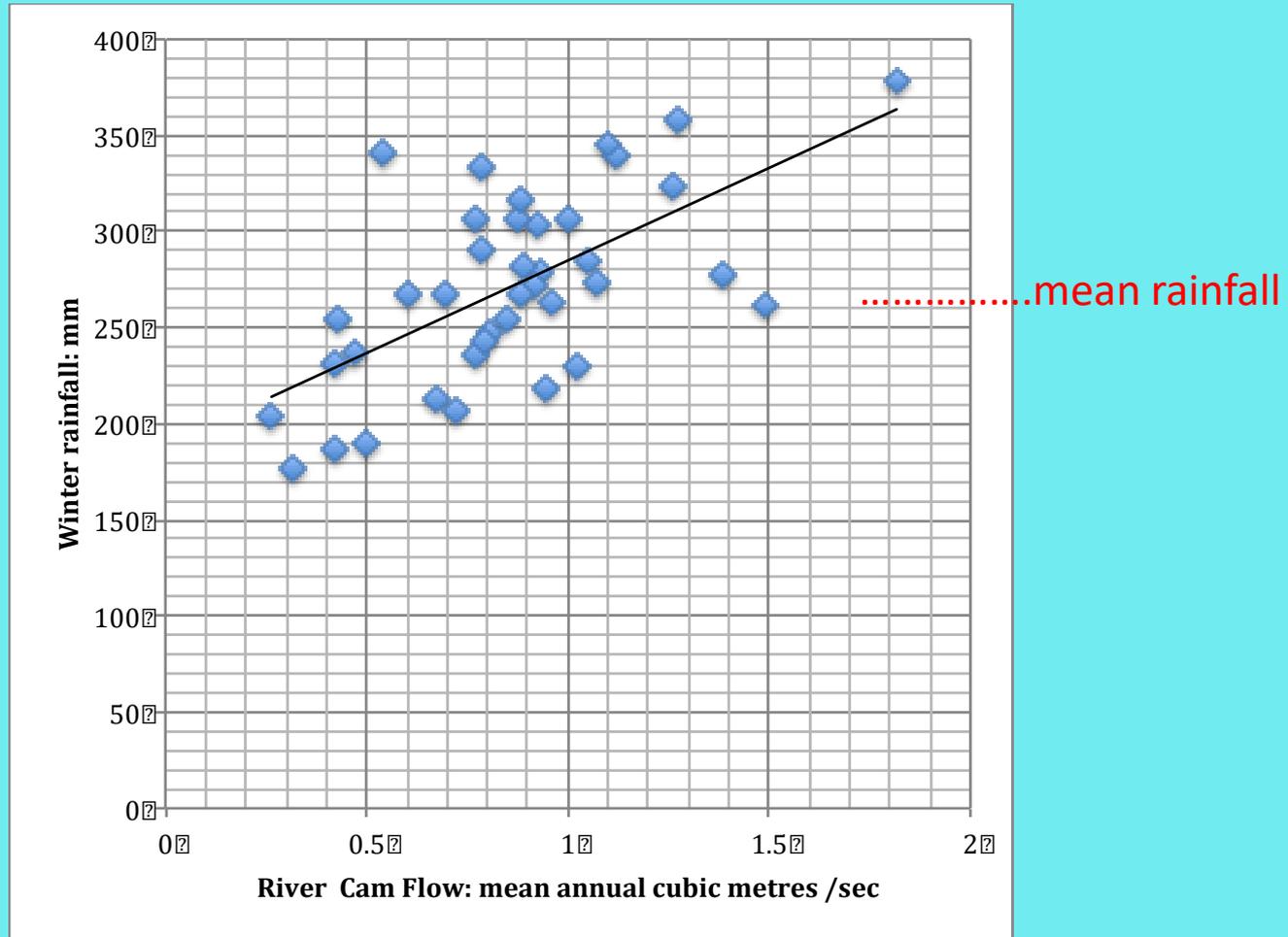
.....Mean

River Cam Flows (for the Upper Cam at Dernford) *Graph from R.Evans EA Data*



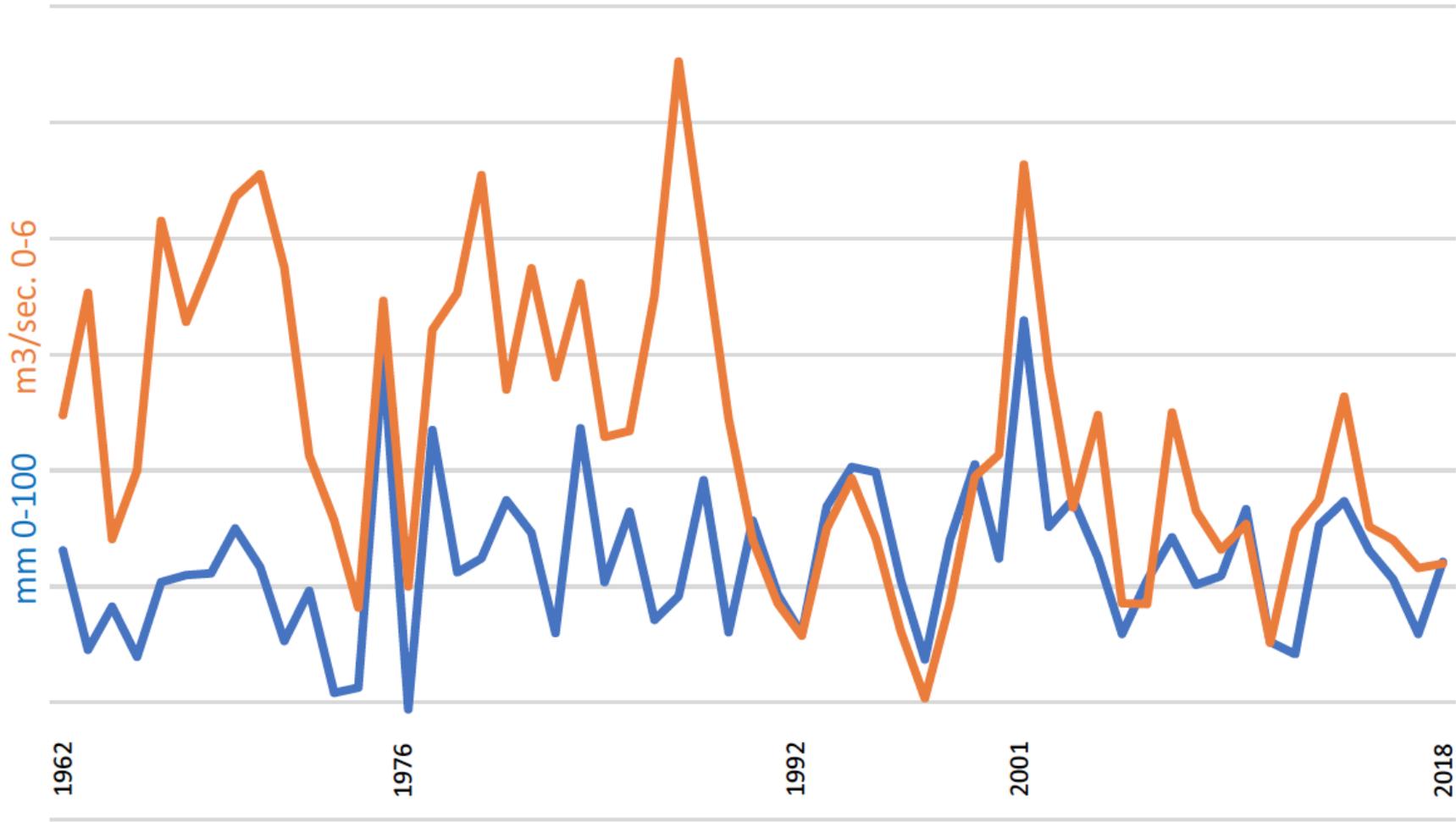
Upper Cam Flow in the last 6 years

1980-2018, a 38 year record of rainfall and annual River Cam flow

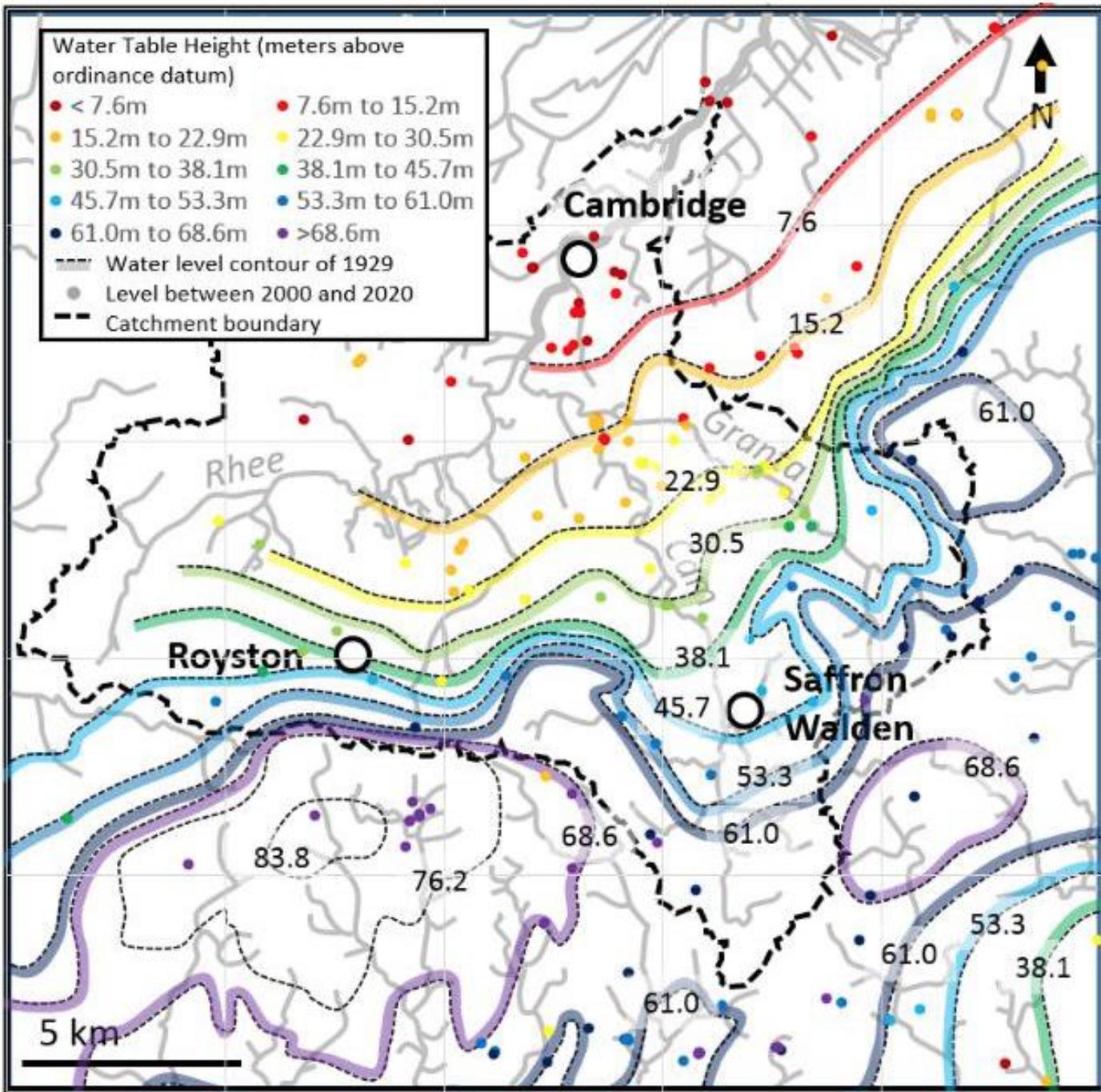


Annual river flow correlates quite well with the previous winter rainfall. More than 200 mm of rain, in winter, is essential for any significant annual river flow at all.

Where is the lost ground water?



Groundwater support was introduced in 1990. Did it really help?

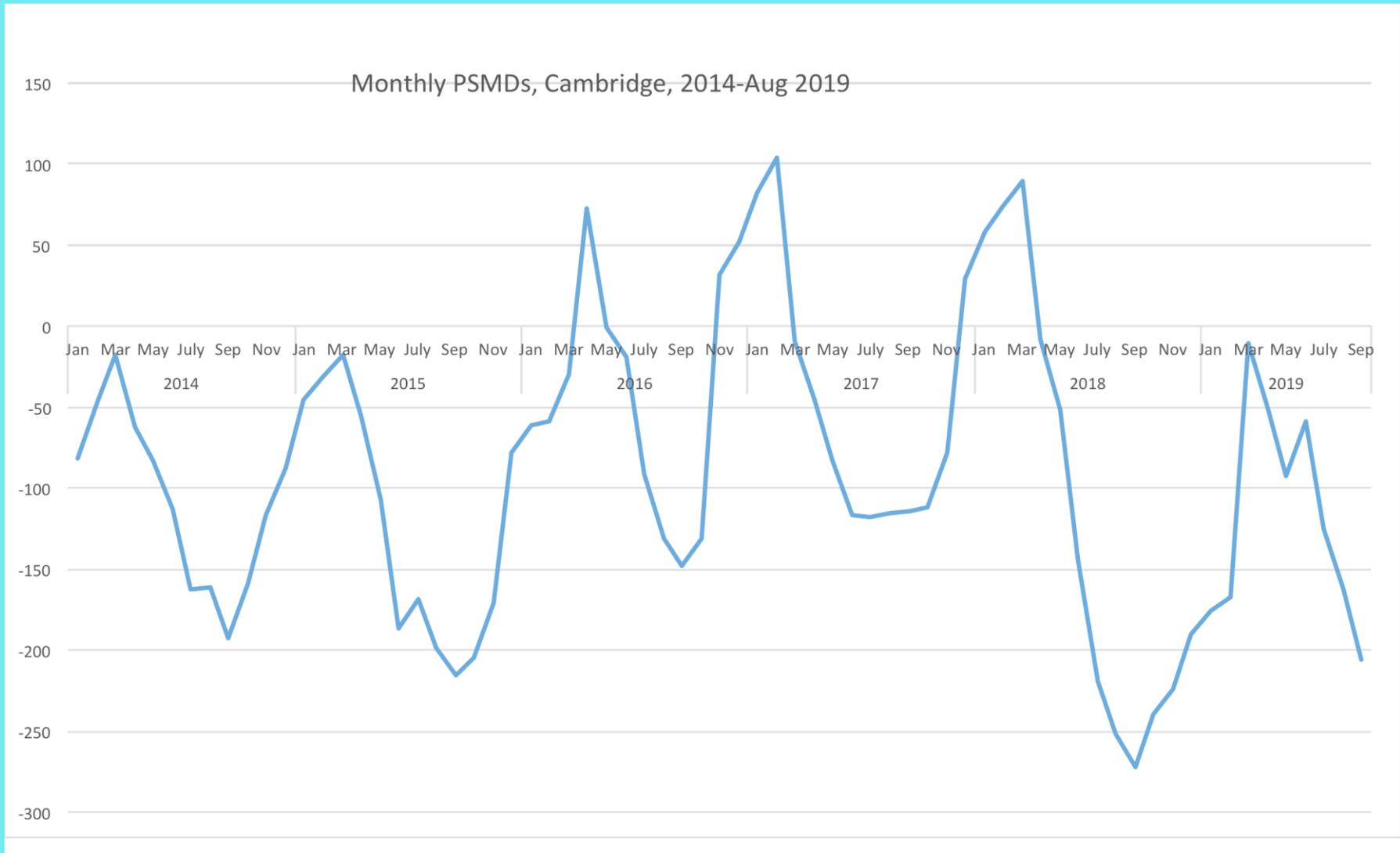


Data from
Joe Stallard:

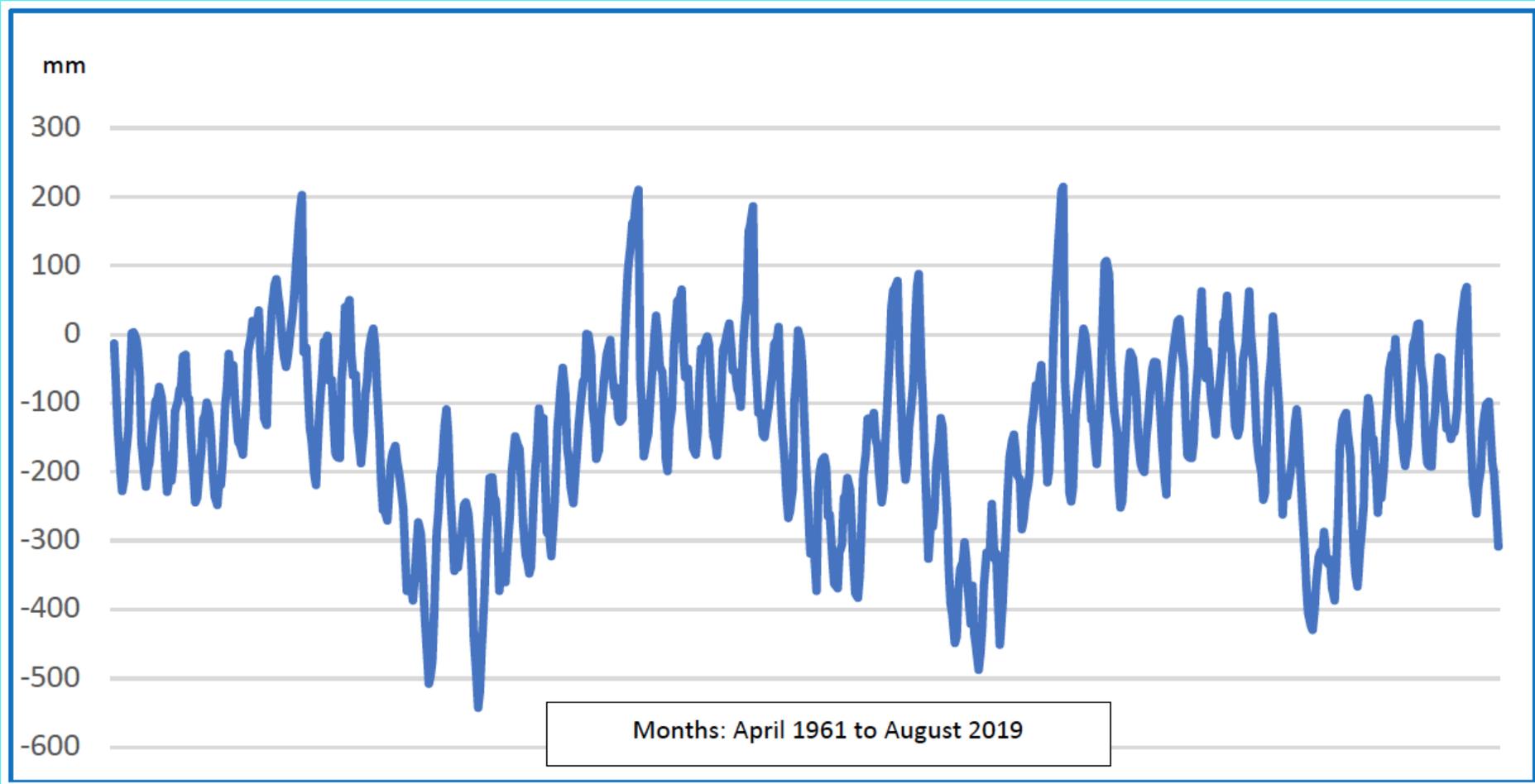
Dept of Engineering C.U.

Decreasing SOIL MOISTURE is possibly part of the answer to our problem

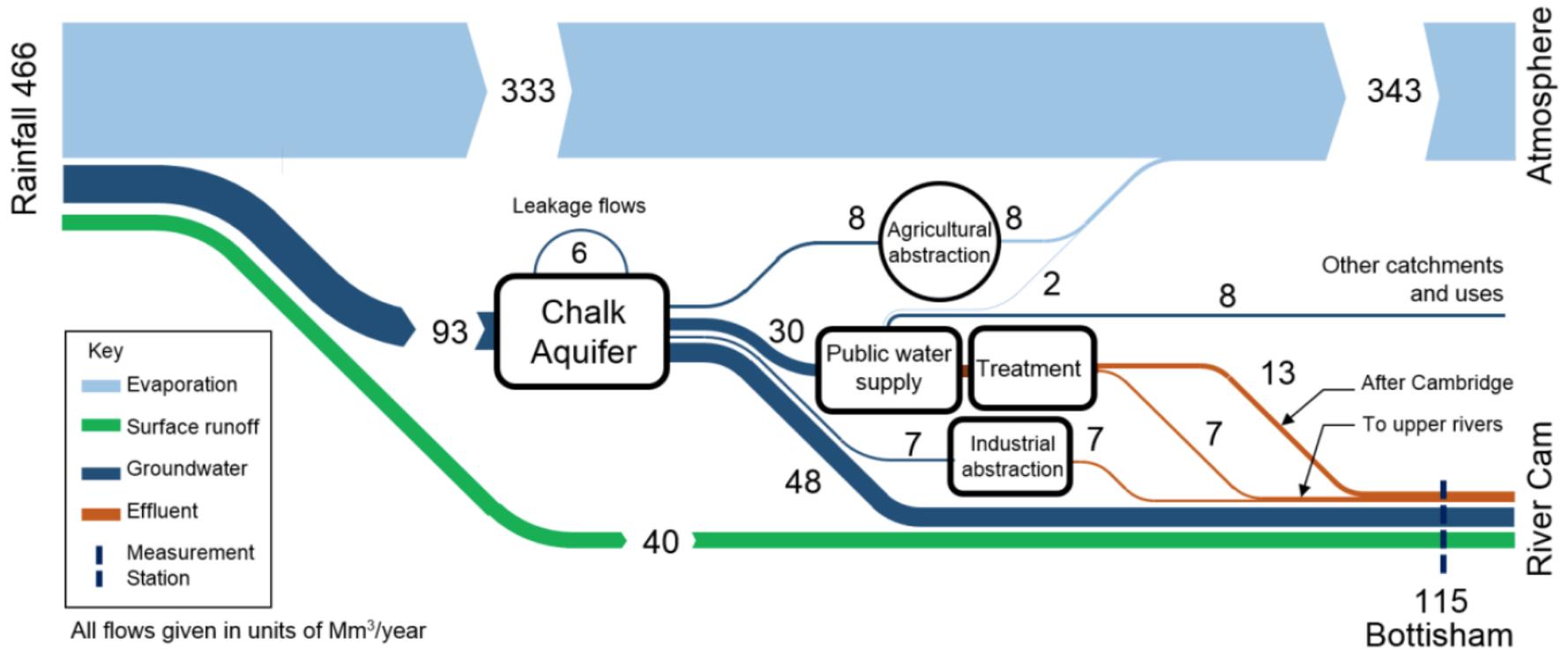
Potential Soil Moisture Deficit (*PSMD*) *Graph and calculations from R.Evans. EA Data*



Groundwater will not recharge at all if there are just slightly drier winters than the mean rainfall (40% of them)



Is it climate change ? This is 58 years of variance in PSMD *(Data from Bob Evans. ARU)*

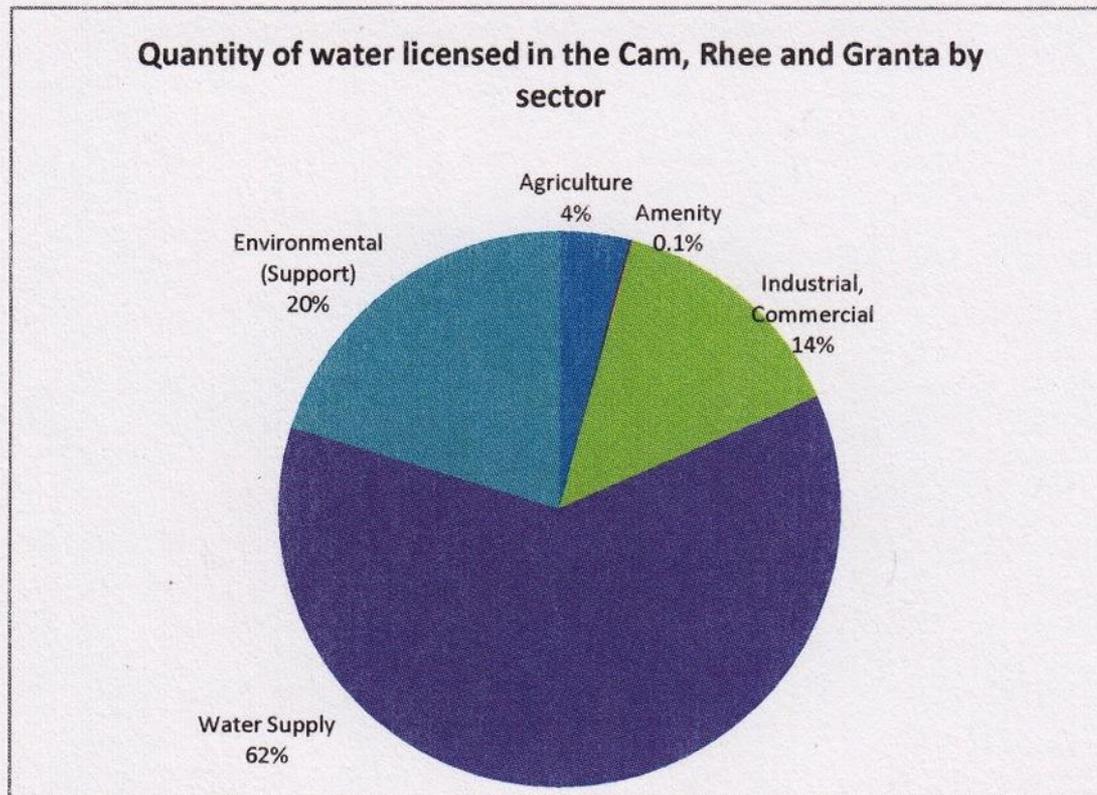


A Sankey Diagram of the Cam's Flow.
 Units are megametres cubed (Mm³)

Base river flow is equal to total abstraction

Total quantity of water licensed in the Cam, Rhee and Granta by sector

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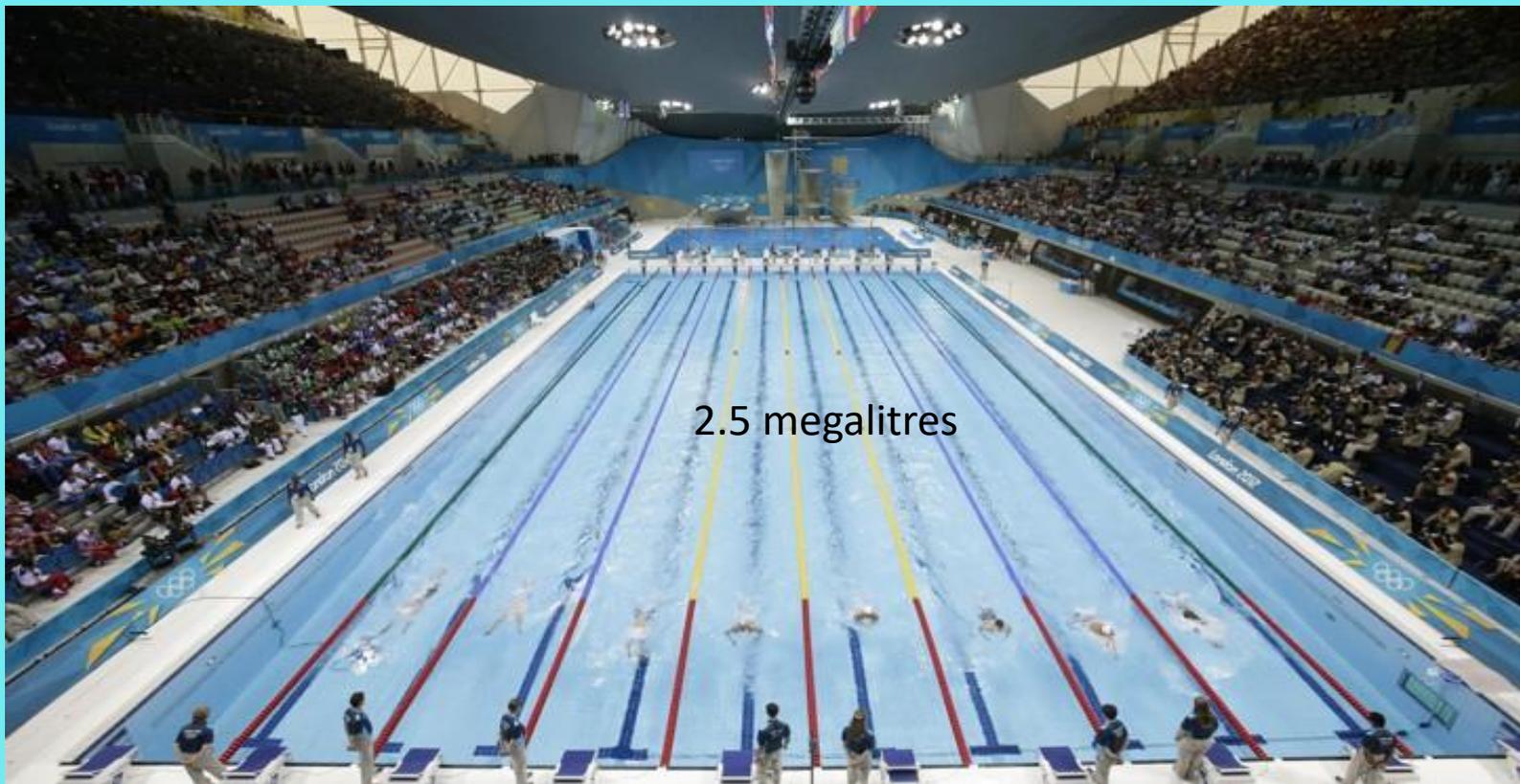
EA Data

From the Upper Cam, Rhee and Granta catchment Affinity Water and Cambridge Water Company currently abstract **54 megalitres** per day (mean). They are licensed (unbelievably) to take up to **90 megalitres** per day. *

The licences have been unchanged for over 20 Years

Can this be sustained in drier years with increasing demand ?

* How big is a **megalitre** ?



The Cam catchment's groundwater Chalk, upstream of Cambridge, is supplying 22 Olympic Swimming pools of water daily to the two local water companies - Affinity Water (37%) and Cambridge Water (South Staffs) (63%). This is largely for our drinking water.

Both Companies are licensed to take as much as **36 Olympic Swimming** pools daily from the Cam. This is > 1 cubic metre /second of river flow.

Cambridge Water Company is licensed to abstract (82 megalitres) 33 Olympic Swimming pools daily from its full catchment. Currently they are well within these set limits.

Some Inconvenient Truths

This is already a water stressed region: Chalk streams are dying across south east England.

The rainfall is unpredictably variable, year on year.

There will be greater droughts than (2018 -2019) in the years ahead.

The summers may well be hotter (> 38.7 C again ?)

In hotter weather more water is used by green plants and people (5-8% in hot summers).

The autumns are now greener for longer, therefore winter recharge time is possibly lessened.

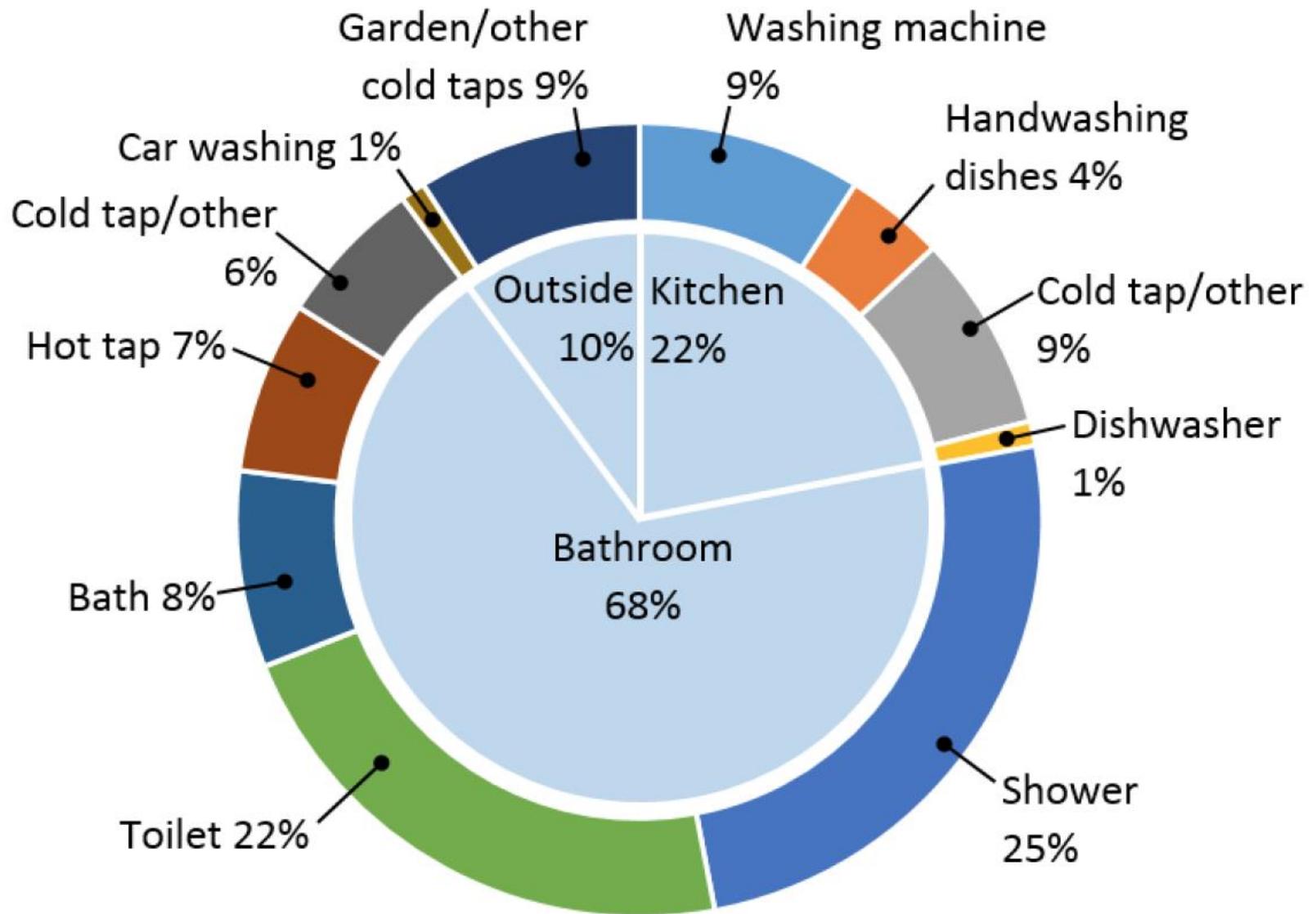
There is not enough water for the environment already

There a very big projected human population increase for the Cambridge region

There is a greater need for better rural environments for all people NOW, and if we are to 'double nature' it cannot be done without water.



Playing Pooh-sticks on the River Mel





How much do people really care about water shortages?

Scarcity does not seem to drive frugality

The majority of people say that they are not concerned about water shortages, but most think that they, the customer, have the responsibility to save water.

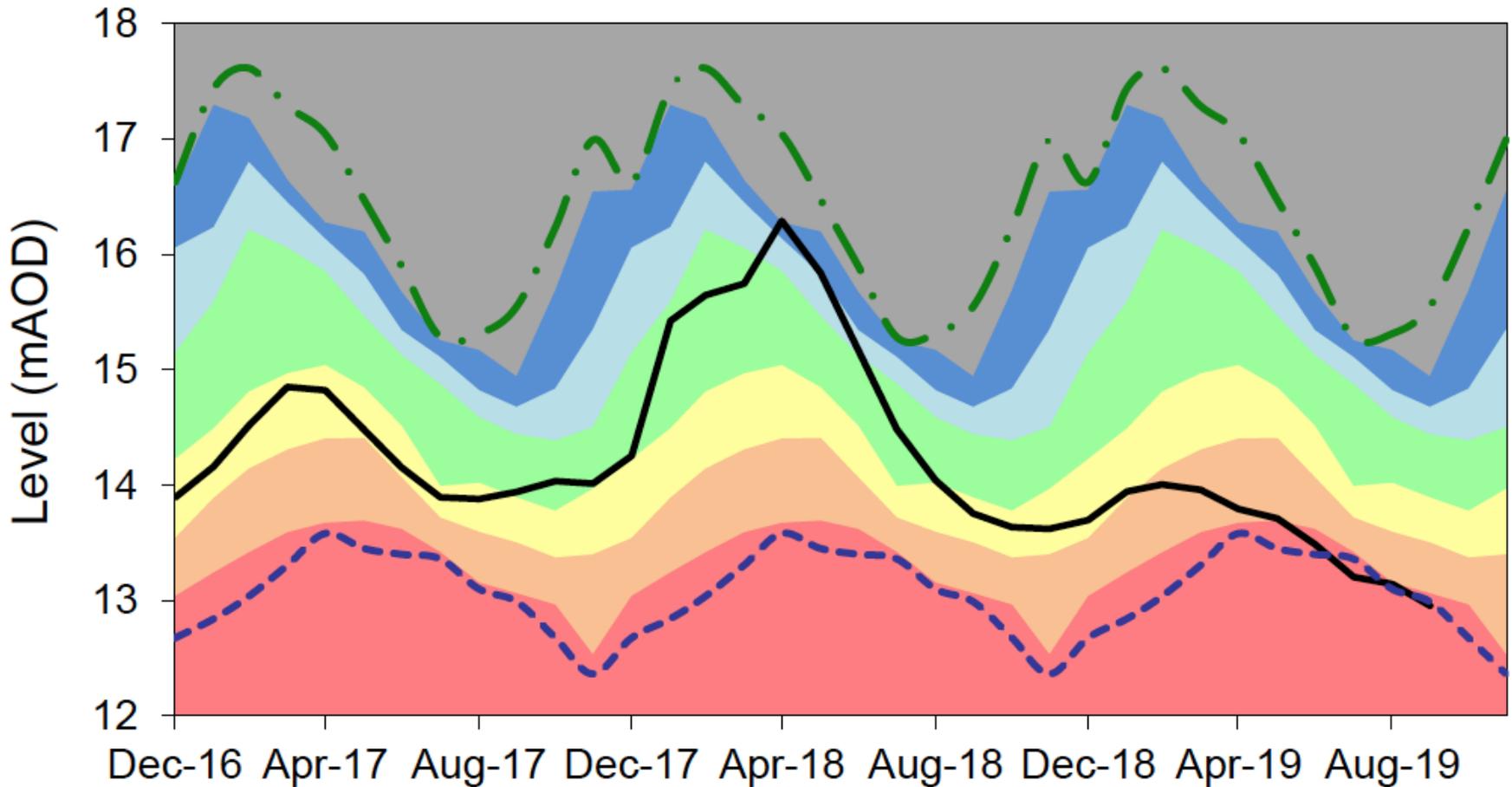
Metering is effective in reducing demand, but the 78% of people who don't have a meter don't want one.

Our questions to the water companies

- Should we not have compulsory metering ?
- Should we have progressive water pricing ?
- Should OfWAT be concerned with Environmental welfare as well as water pricing to consumers?

Gog Magog, Stapleford - CAM CHALK

Ranking derived from data for the period Jan-1980 to Dec-2017

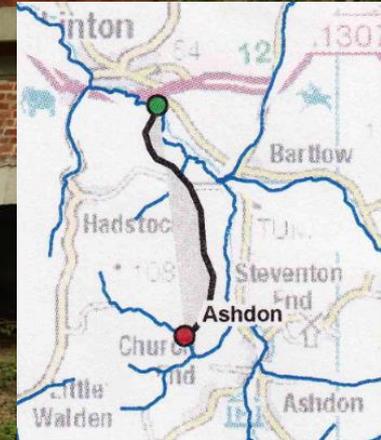


Our Cambridge ground water plummeted in just 18 months



Bartlow Barns, River Granta, 3 km upstream from Linton

In summer 2019 the River Granta had a continuous augmentation from chalk water aquifer, added above Linton, 15 km upstream from this bridge. This was piped into it for 4 months (June to Sept).



Downstream of Linton all the treated sewage effluent was added from the villages of Linton, Haslingfield, Abington, and Babraham.

At Stapleford the river was dry

Where did all that water go?

The Bad River

Impossible to gain easy access to it.

Crowded with boats and people

Scenically ugly

Lacking in heritage value

Pathetic flow

Murky and silt laden water

Polluted with organic matter

High in phosphates and nitrates

Lacking any decent flora except surface duckweed and pennywort

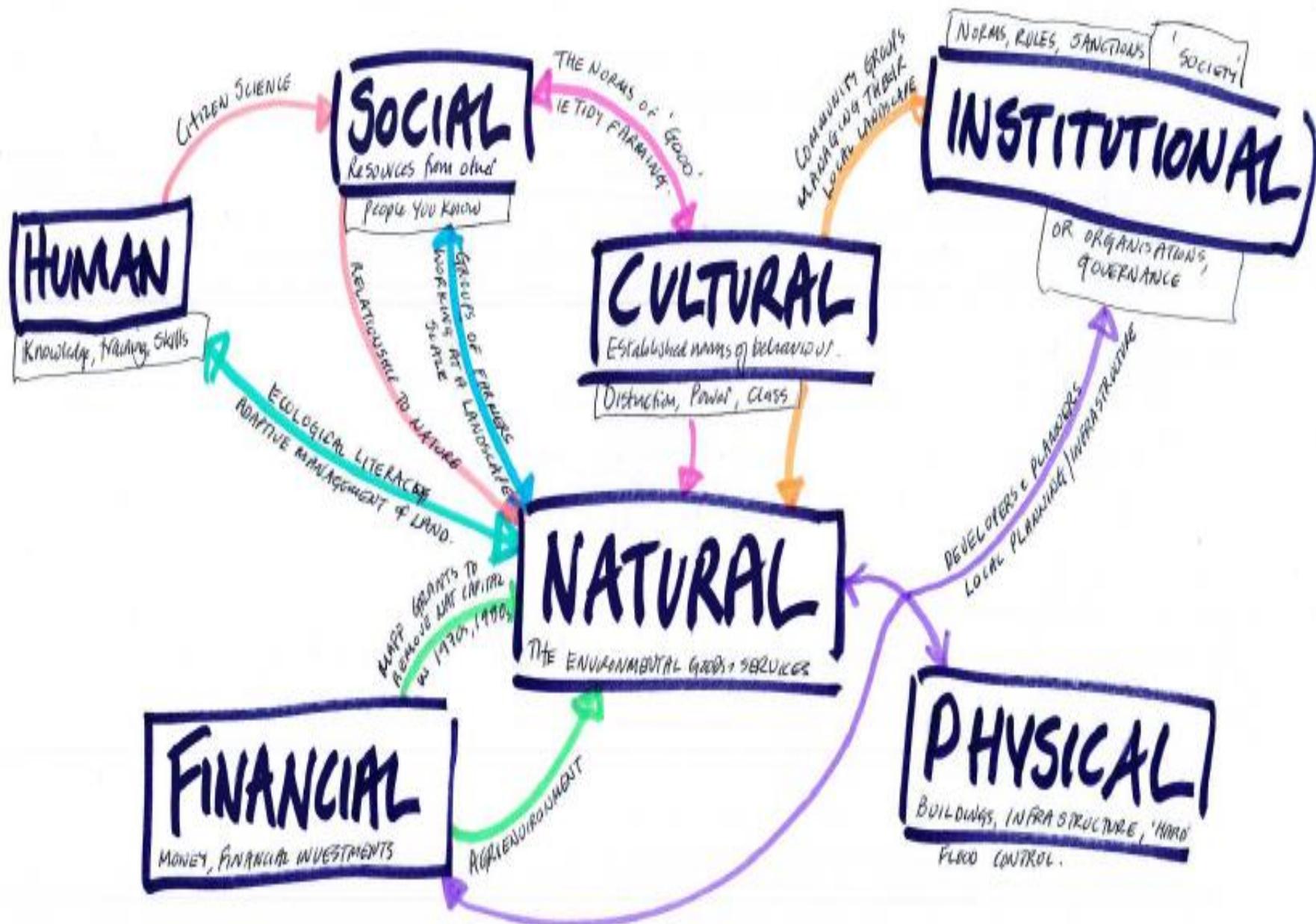
Seemingly lifeless

Worn and beaten down banks, no bank vole habitat

Conflicting recreational activities going on so that users often annoy each other

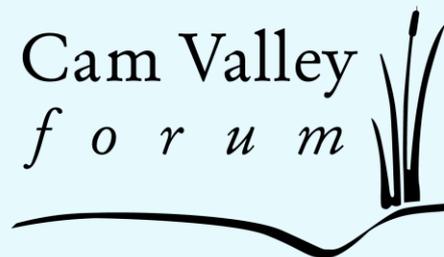
The Good River

Physically and easily accessible for free
Easily accessible to boat, swim or walk by
Spacious for 'free spirits'
Gracious for 'well-being'
Historically interesting
Abundant year-round flow of water
Clear and clean water
Low in soil nutrients
Rich in diverse water plants
Rich with fish and insects
Enlivened with birds and mammals
Spatially zoned for different people's
favoured recreations
Safe from hazards



Jilly Hall (Natural England) : Thinking out the relationships between different sorts of Capital.

Questions ?
&
Discussion of your solutions to the
problem

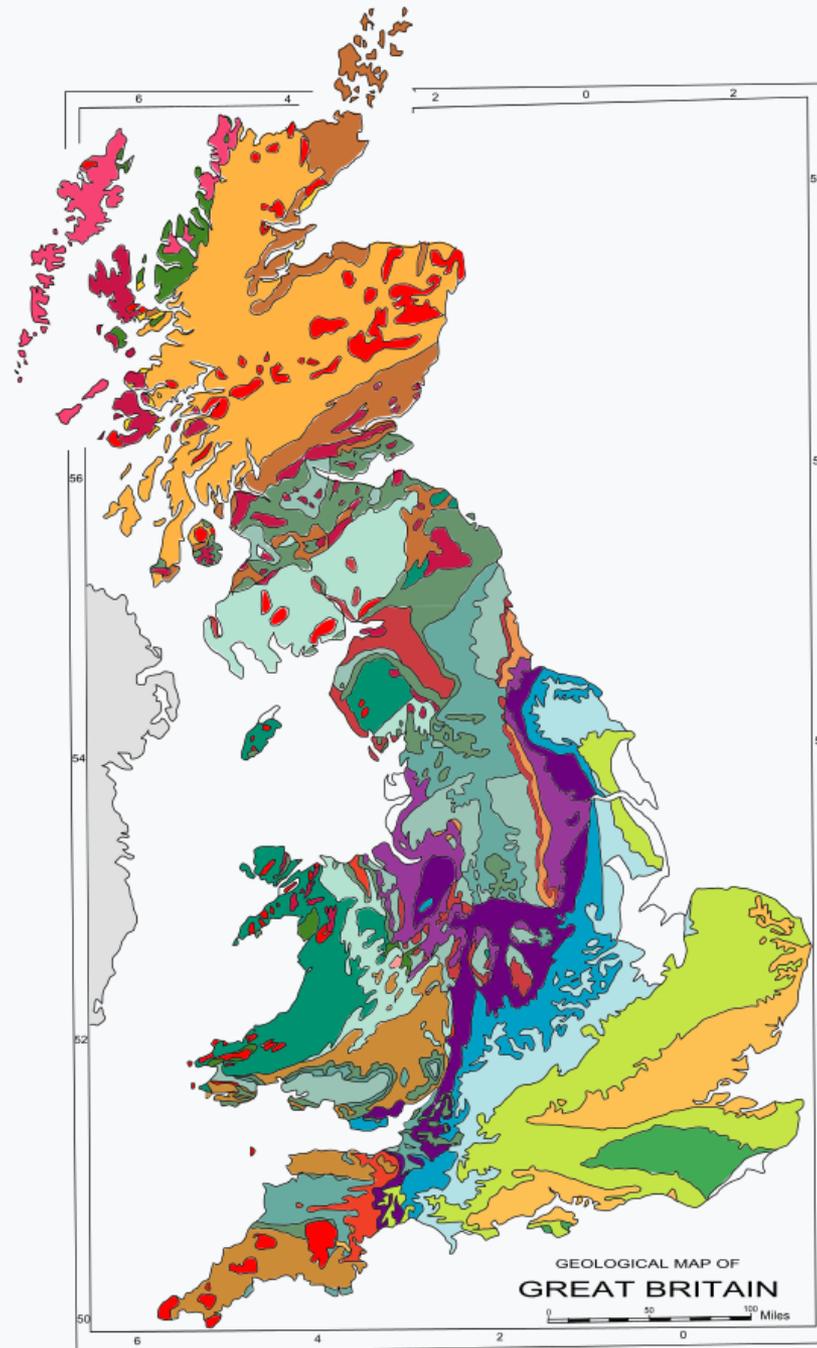




Cam Valley
f o r u m 


Geology of Great Britain

- Quaternary (Alluvium)
- Paleogene / Neogene (Tertiary)
- Cretaceous
- Lower Cretaceous
- middle/upper Jurassic
- lower Jurassic
- upper Triassic
- lower Triassic
- upper Permian
- lower Permian
- upper Carboniferous (Coal Measures)
- middle Carboniferous
- lower Carboniferous (limestone)
- Devonian
- Ordovician / Silurian
- Cambrian
- Neoproterozoic
- Proterozoic (upper Precambrian)
- Lewisian (lower Precambrian)
- granite
- Paleogene volcanics



Geology governs much of a river's chemical nature, physical flow and biological character.

Britain has 85% of all the Chalk streams in Europe and these have an international and EU conservation status

The **Cam**, **Granta** and **Rhee** are all Chalk streams, so too are the Wilbraham River The Cherry Hinton Brook and all the Lodes